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DESCRIPTION OF NEW AND REMARKABLE FOSSILS  
FROM THE PALEOZOIC ROCKS OF THE  
MISSISSIPPI VALLEY.

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BY S. A. MILLER AND WM. F. E. GURLEY.

5 plates

SPRINGFIELD, ILLINOIS,

FEBRUARY 18, 1896.

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DESCRIPTION OF NEW AND REMARKABLE FOSSILS,  
FROM THE PALÆOZOIC ROCKS OF THE  
MISSISSIPPI VALLEY.

BY S. A. MILLER AND WM. F. E. GURLEY.

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SUBKINGDOM ECHINODERMATA.

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CLASS CRINOIDEA.

ORDER PALÆOCRINOIDEA.

FAMILY ACTINOCRINIDÆ.

BATOCRINUS GERMANUS, n. sp.

*Plate I, Fig. 1, basal view; Fig. 2, azygous side, some of the plates of the vault broken away; Fig. 3, summit view of the same specimen.*

Body medium size, calyx and vault subequal, giving it a biturbinate or lenticular shape. Calyx moderately truncated at the base, rapidly spreading and about two and a half times as wide as high; arm openings directed nearly horizontally or directed upward at an angle of only a few degrees; plates thick, very highly convex, this convexity on the radial plates being transverse and angular. No radial ridges. Surface granular.

Basals very short, forming an hexagonal disc, with slight re-entering angles, deeply notched at the sutures, and projecting cuneiform edges a little below the end of the column, and having a round, deep, columnar depression for the attachment of the column. The basal disc is about one-half wider than the diameter of the column. The sutures are notched or beveled nearly to the first radials, and the columnar cavity is deeper. First radials about one-half wider than long, three hexagonal, two heptagonal, with the superior sides slightly arcuate. Each one is transversely convex, the elevation being obtusely angular. Second radials quadrangular, and from one-half to twice as wide as long. Third primary radials rather smaller than



the second, pentagonal, axillary, and bear upon each superior sloping side two secondary radials. The second secondary radials are axillary, and, in three of the rays, bear upon each superior sloping side a single tertiary radial, which gives to each of these rays four arms. The distal side of each ray adjoining the azygous area is constructed in the same way, but the proximal side of each bears an axillary, tertiary radial that bears single quaternary plates, which arrangement gives to each of these rays five arms. There are, therefore, twenty-two arms in this species.

There are three regular interradials in each area, one, followed by two in the second range, which are cut off from the plates of the vault by the union of the tertiary radials. The azygous area is large and subovate. The first plate is in line with the first primary radials and fully as large. It is followed by three rather large plates, in the second range, three somewhat smaller, in the third range, and these by two smaller ones, in the fourth range, that unite with a single, elongated plate belonging to the vault.

The vault is covered with large, convex, polygonal plates and bears a subcentral proboscis. The proboscis commences with rather large tumid plates, but its length is unknown.

In general form this species bears most resemblance to *B. discoideus*, but that species has only a single regular interradial in each area, and only seven plates in the azygous area, which is cut off from the vault by the union of the radial plates. All other species from the Burlington Group having twenty-two arms, heretofore described, are *B. asprailis*, *B. formosus*, *B. luetus*, *B. lepidus*, *B. sinuosus*, *B. turbinalus*, and *B. turbinalus* var. *elegans*. While all these species may be distinguished by the general form, proportional size of the plates and surface characters, they may also be distinguished by the interradial and azygous areas. In *B. asprailis*, there is a single large tumid plate in each regular area, and only five plates in the azygous area, four of which are subequal in size, and the other one is a small, quadrangular plate separating them and resting on the first azygous plate. In *B. formosus*, there are two plates in some of the regular areas and three in others, and eleven plates in the azygous area. In *B. luetus*, there are two plates in each regular area and six in the azygous area. In *B. lepidus*, there are three plates in some of the regular areas and four in others and twelve plates in the azygous area. In *B. sinuosus*, there are from six to eight plates

in each regular area, and fifteen or sixteen in the azygous area, and all the areas connect with the vault. In *B. turbinatus*, there are three plates, one following the other, or three ranges, the middle one having two plates in each regular inter-radial area, and ten plates in the azygous area, the last one of which is elongated and connects with the plates of the vault. In *B. turbinatus*, var. *elegans*, there are three plates in each regular area, one following the other, and eight or nine plates in the azygous area. *B. aspratilis* and *B. laetus* were described from Sedalia, Missouri, and among the forms received from there we have recognized *B. discoidens* and *B. turbinatus*, which were described from Burlington, Iowa.

Found by R. S. Blair, in the Burlington Group, at Sedalia, Missouri, and now in the collection of S. A. Miller.

BATOCRINUS PROXIMUS, n. sp.

Plate I, Fig. 4, basal view; Fig. 5, side view.

Body medium size, somewhat biturbinate, though the calyx is larger than the vault. Calyx obconoidal, most rapidly spreading toward the free arms, truncated at the base, a little less than twice as wide as high; arm openings directed upward at an angle of twenty or thirty degrees; plates tumid, leaving the sutures much depressed; surface finely granular.

Basals form a short, hexagonal disc, with slight re-entering angles. The disc is notched at the sutures, and has a round, deep, columnar depression for the attachment of the column; it is less than twice the diameter of the column. The basal plates expand below and project cuneiform edges below the end of the column. First radials from one-half wider to twice as wide as long, three hexagonal, two heptagonal, with the superior edges slightly arcuate. Second primary radials quadrangular, from two to two and a half times as wide as high. Third primary radials larger than the second, pentagonal, axillary, and bear upon each superior sloping side two secondary radials. The second secondary radials are axillary, and, in three of the rays, bear upon each superior sloping side two tertiary radials, which gives to each of these rays four arms. The distal side of each ray, adjoining the azygous area, is constructed in the same way, but the proximal side of each bears an axillary, tertiary radial that supports quaternary plates, which arrangement gives to each of these rays five arms. There are, therefore, twenty-two arms in this species.

There are three regular interradials, in each area, one, followed by two of unequal size, in the second range, which are cut off from the plates of the vault by the union of the tertiary radials. The azygous area contains seven plates. The first one is in line with the first primary radials and fully as large as any of them. It is followed by three rather large plates, subequal in size, in the second range, and by three smaller plates in the third range, that are cut off from the plates of the vault by the union of the quaternary plates.

The vault is covered with highly convex or tumid polygonal plates and bears a subcentral proboscis, which is not preserved in our specimens.

The general form of this species will readily distinguish it from such twenty-two armed species as *B. discoideus*, and *B. germanus*, without calling attention to the extra tertiary radial, in each series, or the differences in the interradial areas. It is more like *B. lactus* than any other described species, but may be distinguished by the general character of the plates, which is conspicuous when the basals are compared, and by the direction of the arm openings, as well as by the interradial areas. In that species there are two regular interradials in each area, and in this species there are three. In that species there are six azygous plates, and in this species there are seven. In this species the calyx expands more rapidly than in that one, and the vault is elevated, in that species, over the arm openings more than it is in this one.

Found by R. A. Blair, in the Burlington Group, at Sedalia, Missouri, and now in the collection of S. A. Miller.

BATOCRINUS HODGSONI, n. sp.

*Plate I, Fig. 6, azygous side; Fig. 7, side view. The specimen is compressed so as to widen the side view and contract the azygous view.*

Species medium size, biturbinate, calyx larger than the vault. Calyx bell-shaped, rounded below and most rapidly expanding as the arms are approached; nearly as high as wide. Arm openings directed very little above a horizontal line. No radial ridges. Plates convex only in the region of the last radials. Surface smooth or finely granular.

Basals form a cup about half as high as wide and truncated by a small column and bearing a concave facet for its attachment. First radials larger than the basals and rather longer

than wide, three hexagonal, two heptagonal and rising almost vertically from the basals. Second radials quadrangular, about half as wide as the first, but nearly twice as wide as long. Third radials a little larger than the second, three hexagonal, two pentagonal, axillary and bear upon each superior sloping side the secondary radials. In the ray opposite the azygous side and in one of the lateral rays there are two secondary radials, in each series, the last one much longer than the first, which gives to each of these rays two arms. In each ray adjoining the azygous area there are two secondary radials on the distal side and one on the proximal side which is axillary and bears upon each upper sloping side a single tertiary radial. One of the lateral rays is constructed in the same way. Each of these three rays bears three arms. It is also to be observed that the radials which support the arms are longer than those immediately below. There are, therefore, in this species thirteen arms.

In one of the regular interradian areas there are three plates, one followed by two in the second range. In the other areas there are only two plates, one following the other. These areas do not connect with the vault. In the azygous area there are seven plates. The first one is in line with the first primary radials and is the largest plate in the body. It is followed by three plates in the second range and three in the third range. The middle plate in the third range is elongated, separates the tertiary radials and unites with two plates belonging to the vault.

Vault elevated, convex, and bears a submarginal proboscis. It is covered with large, polygonal, smooth plates.

This is the first species of *Balocrinus* bearing only thirteen arms that has ever been described, from the Burlington Group, and its arm formula, therefore, is sufficient to distinguish it from all other species. In form, it approaches more nearly *B. christyi*, which has twenty arms, than any other species.

Found by Mr. C. S. Hodgson, a naturalist of Albion, Illinois, in whose honor I have proposed the specific name, in the Burlington Group, in Adams County, Illinois, and now in the collection of S. A. Miller.

BATOCRINUS ARGUTUS, n. sp.

*Plate I, Fig. 8, azygous side; Fig. 9, opposite view.*

Body medium size, calyx and vault, subequal in size, making it biturbinate. Calyx rather broadly truncated below, and most

rapidly spreading toward the free arms. About twice as wide as high. Arm openings directed nearly horizontally. No radial ridges. Plates thick and highly convex or tumid. Surface granular.

Basals form an hexagonal disc, with slight re-entering angles, deeply notched at the sutures, and project cuneiform edges, slightly expanding, below the end of the column. The basal disc is about one-half wider than the diameter of the column, and bears a deep concave depression for the attachment of the column. First radials about one-half wider than long, three hexagonal, two heptagonal, and transversely, highly tumid. Second radials quadrangular, and from two to three times as wide as long. Third primary radials about one-half larger than the second, pentagonal, axillary, and bears upon each upper sloping side secondary radials. In four of the rays there are, upon each upper sloping side of the third primary radials, two secondary radials the last one being axillary and supporting upon each upper sloping side two tertiary radials, which gives to each of these rays four arms. In the ray on the left of the azygous area, there are, on the distal side of the third primary radial, two secondary radials, the last being axillary and supporting, on one side, a single tertiary radial, and upon the other two tertiary radials. The third primary radial bears on the proximal side two secondary radials, the last being axillary and bearing on the distal side two tertiary radials, and on the proximal side one tertiary radial which is axillary and bears on the distal side one quaternary radial which gives to this ray five arms. There are, therefore, in this species twenty-one arms.

There are two regular interradians in each area. The first one is large and tumid, the second one small. There are six plates in the azygous area. The first one is in line with the first primary radials, tumid and about as high as wide. It is followed by three tumid plates in the second range and by two smaller plates in the third range, that are cut off, by the tertiary and quaternary radials, from all connection with the vault.

The vault is elevated, convex, covered with tumid, polygonal plates, and bears a large, subcentral proboscis. The plate at the base of the proboscis opposite the azygous area is the largest plate connected with the vault.

This is the first species of *Batocrinus*, bearing twenty-one arms, that has been described, from the Burlington Group,



and its arm formula, therefore, is sufficient to distinguish it from all other species. In form, it approaches *B. laetus* which has twenty-two arms, but may also be distinguished from it by the azygous area and other peculiarities.

Found by R. A. Blair, in the Burlington Group, at Sedalia, Missouri, and now in the collection of S. A. Miller.

BATOCRINUS BASILICUS, n. sp.

*Plate I, Fig. 10, azygous side; Fig. 11, opposite view; Fig. 12, summit view.*

Body medium or below medium size and somewhat biturbinate, though the calyx is decidedly larger than the vault. Calyx truncated below and obconoidal above, though spreading most rapidly as the free arms are approached. About twice as wide as high. Arm openings directed horizontally. No radial ridges. Plates convex. Surface granular.

Basals very short and form a low hexagonal disc, with slight re-entering angles. The basal disc is about one-third wider than the diameter of the column and bears a shallow, radiately lined, concave depression for the attachment of the column. First radials a little wider than high, three hexagonal, two heptagonal, with the superior sides slightly arcuate. Second radials quadrangular, about half as wide as the first radials, but two or three times as wide as long. Third primary radials about the size of the second, pentagonal, axillary and bear upon each superior sloping side two secondary radials, the last one of which is axillary and bears upon each upper sloping side, in three of the rays, a single tertiary radial, which gives to each of these rays four arms. In each ray adjoining the azygous area there is, on the distal side of the distal second, secondary radial, an axillary tertiary radial, which bears upon each superior sloping side a single quaternary radial, and on the proximal side two tertiary radials; and on the distal side of the proximal second secondary radial, two tertiary radials, and on the proximal side a single axillary tertiary radial, which bears upon each upper sloping side a single quaternary radial, which arrangement gives to each of these rays six arms. There are, therefore, twenty-four arms in this species.

There are three plates in each regular interradiar area, one followed by two small ones in the second range that do not connect with the vault. There are ten plates in the azygous area. The first one is in line with the first primary radials,

and the largest plate in the body. It is followed by three plates in the second range, three smaller ones in the third range, two in the fourth range and one narrow, elongated plate in the fifth range, that separates the quaternary radials and unites with two plates that belong to the vault.

Vault convex, moderately depressed toward the interradial areas and strongly depressed toward the azygous area, and covered with numerous convex, polygonal plates. It bears a rather large, subcentral proboscis.

This is the only species of *Batocrinus* having twenty-four arms, from the Burlington Group, except *B. quasillus*, and it is so different, in general form and in the structure of the azygous and interradial areas from that species, that no comparison is necessary to distinguish it. It is quite unnecessary to compare it with any other species.

Found by R. A. Blair, in the Burlington Group, at Sedalia, Missouri, and now in the collection of S. A. Miller.

#### BATOCRINUS ASPERATUS, n. sp.

*Plate I, Fig. 13, azygous view; Fig. 14, side view.*

Body about medium size, lanterniform or urn-shaped. Calyx broadly truncated below and slowly expanding above; about one-third wider than high. Arm openings directed upward at an angle of about thirty degrees. No radial ridges. Plates tumid and spiniform. Surface smooth or finely granular.

Basals short, forming an hexagonal disc, with re-entering angles, deeply notched at the sutures and projecting cuneiform edges below the end of the column and having a shallow concave depression for the attachment of the column. The basal disc is more than one-half wider than the diameter of the column. First radials a little wider than high, three hexagonal, two heptagonal, and each one bears a transverse cuneiform spine. Second radials quadrangular, two or three times as wide as long. Third radials larger than the second, pentagonal, axillary, and support on each upper sloping side two secondary radials, the last one being axillary and supporting on each upper sloping side a single tertiary radial, except on the proximal sides of the rays adjoining the azygous area, where there are two tertiary radials. There are, therefore, four arms to each ray, or twenty arms in this species. There is only one regular interradial in each area and it is spiniform. In the azygous area there are four spiniform plates. The first one is

in line with the first primary radials, and it is followed by three plates, in the second range, that are cut off from the vault by the tertiary radials.

The vault is convex and covered with polygonal spiniform plates and bears a very small, central proboscis (?). Two plates appear to be broken out of the center of the summit of our specimen, and if they indicate a proboscis it was quite small, probably not elevated much above the summit of the vault.

This is a very peculiar species, having a shape somewhat like *Eretmocrinus konincki*, which is a *Balocrinus*, but distinguished from it by having twenty instead of eighteen arms, four instead of ten plates in the azygous area, by having the azygous area cut off from the vault instead of being connected with it, and by having a much smaller proboscis, more spiniform plates and other peculiarities.

Found by Mr. C. S. Hodgson, in the Burlington Group, in Adams county, Illinois, and now in the collection of S. A. Miller.

BATOCRINUS ASPER, n. sp.

*Plate I, Fig. 15, basal view; Fig. 16, azygous side of calyx, part of one of the tertiary radials over the azygous area is broken away.*

Species medium size. Calyx low, broadly truncated and rapidly expanded. Nearly three times as wide as high. Plates very tumid and radiately furrowed. Vault, proboscis and arms unknown.

Basals form a flat, hexagonal disc with strong, re-entering angles. It is on a level with the lower, flattened face of the first primary radials and bears a slightly concave, radiately lined facet for the attachment of the column, which is about equal to half the diameter of the disc. The columnar canal is of moderate size and cinquefoil. First primary radials a little wider than long, three hexagonal, two heptagonal, and sculptured pyramidal. Second primary radials quadrangular, about one-half wider than long and sculptured pyramidal. Third primary radials a little larger than the second, pentagonal, axillary, pyramidal, and bear upon each superior sloping side a single secondary radial, which is axillary and bears upon each upper sloping side a single tertiary radial, which gives to each ray four arm openings to the vault. There are, therefore, twenty arms in this species.

There are three regular interradials in each area, one pyramidal plate followed by two small ones that are cut off from the vault by the tertiary radials. There are four plates in the azygous area. The first one is in line with the first primary radials of the same size. It is followed by only two plates in the second range and one plate in the third range, which is cut off from the vault by the tertiary radials.

The sculpturing of this species is quite different from that of any other twenty armed species. The form, too, is different and so is the azygous area. It cannot be mistaken for any other species.

Found by R. A. Blair in the Burlington Group, at Sedalia, Missouri, and now in the collection of S. A. Miller.

BATOCRINUS ADAMSSENSIS, n. sp.

*Plate I, Fig. 33, azygous side; Fig. 34, opposite view; Fig. 35, summit view.*

Species below medium size. Calyx bowl-shaped, slightly pentagonal, which is most strongly marked when seen from above; less than one-half wider than high. Plates convex; sutures distinct. Radial ridges undefined, though interradial areas are somewhat flattened. Surface finely granular. Column medium size and pierced by a large, cinquefoil canal.

Basals form a low, hexagonal disc, which slightly expands upward and has a diameter full twice as great as the diameter of the column. The lower and outward sides of the basals are convex or rounded. The first primary radials are large and have a height nearly as great as the diameter, three hexagonal and two heptagonal. Second primary radials small, quadrangular, two or three times as wide as high. Third primary radials about twice as large as the second, pentagonal, axillary and support on each superior sloping side two secondary radials. There are, therefore, ten arms in this species.

All of the interradial areas connect with the plates belonging to the vault. In the regular interradial areas the first plate is followed by two elongated plates in the second range, which unite with one or two plates which separate the arms and unite with the plates of the vault. In the type specimen, two plates may be distinguished in the third range, in three of the areas, but in the other area only one can be distinguished, though possibly there are two also. The first plate in the azygous area is the largest plate in the body. It is longer

nan a first primary radial and in line with them. It is followed by three plates in the second range, two quite small plates in the third range and three plates in the fourth range that separate the arms and unite with four plates belonging to the vault.

The vault is only moderately convex and terminates in a large subcentral proboscis, that is broken away from our specimen. The vault is covered with numerous, slightly convex, polygonal plates.

This is the first ten armed species of *Batocrinus* described from the Burlington Group, and is so far removed from all others that no comparison with any of them is necessary.

Found by C. S. Hodgson in the Burlington Group, in Adams County, Illinois, and now in the collection of S. A. Miller.

BATOCRINUS FOLLICULUS, n. sp.

*Plate I, Fig. 36, azygous view; Fig. 37, opposite side; Fig. 38, summit view.*

Species medium or below medium size and ovoid in outline. Calyx broadly rounded below and contracted above the third radials so as to make it somewhat globular. The length is about equal to the diameter at the bases of the arms, but the greatest diameter is below, in the region of the third primary radials. Plates convex and sutures distinct. No radial ridges. Surface finely granular. Column small.

Basals form a very low hexagonal disc, which expands upward and is concave below for the reception of a small column. The basals are so short that they hardly interrupt the general globular form of the calyx below. First primary radials rapidly expand and with the radials form a low saucer-shaped cup. Their length is nearly equal to their breadth, three hexagonal and two heptagonal. Second primary radials, quadrangular, and from one-half wider to twice as wide as long. Third primary radials very little if any larger than the second, pentagonal, axillary, and support on each superior sloping side two secondary radials. There are, therefore, ten arms in this species.

The first regular interradianals are large, convex plates. There are two plates in the second range, one of which is elongated and in some of the areas appears to connect with a plate belonging to the vault, and, in other areas, the last secondary radials appear to unite and cut off the interradianal area. The



first azygous plate is in line with the first primary radials, and though longer is somewhat smaller than either of them. It is followed by two large, nearly equal plates, in the second range, one in the third range, and one narrow, elongated plate in the fourth range that unites with the plates of the vault.

The vault is conoidal and terminates in a large subcentral proboscis, which is broken off in our specimen, as shown in the illustration. The vault is covered with a few large, convex plates.

It is unnecessary to compare this species with *B. adamsensis*, above described, and it is so different from all other *Batocrinus* that no comparison with any of them will show any near affinity to it. It is a well marked and peculiar species.

Found by R. A. Blair, in the Burlington Group, at Sedalia, Missouri, and now in the collection of S. A. Miller.

BATOCRINUS MODULUS, n. sp.

*Plate I, Fig. 39, basal view; Fig. 40, azygous side; Fig. 41, summit view.*

Species small. Calyx broadly rounded below, hemispherical, nearly two and a half times as wide as high. No radial ridges or convex plates. Arm openings directed upward at an angle of ten or twenty degrees. Surface granular.

Basals substantially covered by the end of the column, and bear a moderately concave depression for the attachment of the column, which is also supported by a little rim around the outside of the concavity. First primary radials nearly as long as wide, three hexagonal, two heptagonal. Second primary radials quadrangular, three or four times as wide as long. Third primary radials about one-half larger than the second, pentagonal, axillary, and in the ray opposite the azygous area bears upon each upper sloping side two secondary radials, which gives to this ray two arms. In one of the lateral rays the third primary radial supports upon each superior lateral side a single secondary radial which is axillary and supports on each upper sloping side a single tertiary radial, which gives to this ray four arms. In each ray adjoining the azygous area the third primary radial bears upon the distal side two secondary radials and on the proximal side one secondary radial which is axillary and bears upon each superior sloping side a single tertiary radial, which gives to each of these rays

three arms. The other lateral ray is constructed, in like manner, and bears three arms. There are, therefore, fifteen arms in the species.

There are two regular interradians in each area, one following the other and cut off from the vault by the union of the secondary and tertiary radials. In the azygous area there are four plates. The first is in line with the first primary radials and of about the same size. It is followed by three plates in the second range, the middle one of which is large and elongated and extends to the plates of the vault.

The vault is highly convex, covered with polygonal plates and bears a very small, subcentral proboscis, which is broken off at the top of the vault in our specimen.

This species is quite peculiar in its form and structure and the first species ever described, from the Burlington Group, which possessed fifteen arms.

Found by Mr. C. S. Hodgson, in the Burlington Group, in Adams county, Illinois, and now in the collection of S. A. Miller.

BATOCRINUS NANUS, n. sp.

*Plate I. Fig. 42, azygous view; Fig. 43, opposite side; Fig. 44, summit view.*

Species small, below medium size, biturbinate, calyx larger than the vault. Calyx obconoidal, somewhat pentagonal, in the superior part, by reason of a flattening or slight depression of the interradian areas; about one-half wider than high. Radial ridges undefined. Plates slightly convex; surface finely granular.

Basals form a low hexagonal disc, but are so injured in our specimen that a particular definition cannot be given of them. First primary radials large, nearly as long as wide, three hexagonal, two heptagonal. Second primary radials small, from one-half wider to twice as wide as long, quadrangular. Third primary radials about one-half larger than the second, pentagonal, axillary, and support on each superior sloping side a single secondary radial. There are, therefore, ten arms in this species.

All of the interradian areas connect with plates belonging to the vault. In the regular interradian areas the first plate is followed by two plates, in the second range, which unite with two plates, about on a level with the top of the secondary radials. The last two plates cover part of the ambulaeal canals and, therefore, properly belong to the vault. The first plate, in the azygous area, is longer than a first primary radial,

and nearly as large and in line with them. It is followed by three plates in the second range, which are subequal, in size. These are followed by two plates in the third range that unite with three plates belonging to the vault.

The vault is obconoidal and is produced in a large subcentral proboscis. It is covered with numerous, convex, polygonal plates.

This species most resembles *B. adamsensis* and seems to have no near affinity with any other described species. The two species, however, may be readily distinguished by the general form, for this species is much more elongate and biturbinate, in outline, than that species. There is only one secondary radial in this species, and there are two in that. The plates in the azygous areas are quite different, and there is one more range, having three plates, in that species, than there is in this.

Found in the Burlington Group, by R. A. Blair, at Sedalia, Missouri, and now in the collection of S. A. Miller.

BATOCRINUS CISTULA, n. sp.

*Plate 1, Fig. 24, azygous view, a little compressed on one side; Fig. 25, basal view; Fig. 26, summit view.*

This species is medium size. Calyx bowl-shaped, moderately truncated below and rounding and spreading to the arms; about twice as wide as high. Plates moderately convex and beveled toward the sutures. Ambulacral openings directed upward at an angle of ten to twenty degrees. No radial ridges.

The basals form an hexagonal disc that bears a rounded rim or band around the end of the column. The disc bears a concave, radiately furrowed depression for the attachment of the column. First primary radials large, from one half wider to twice as wide as long, three hexagonal, two heptagonal. Second primary radials, about half as large as the first, quadrangular, from two and a half to three times as wide as long. Third primary radials about as large or smaller than the second primary radials, two hexagonal, three pentagonal, axillary, and in four of the rays support upon each superior sloping side two secondary radials, the last being axillary and bearing upon each upper sloping side two secondary radials. In some of the rays there are three secondary radials, which gives to each of these rays four arms. In the ray opposite the azygous area the third primary radial bears upon each upper side three secondary radials, which gives to this ray two arms. There are, therefore, eighteen arms in this species and eighteen arm openings to the vault.

There are three plates in each regular interradiar area, one large plate followed by two small ones, that are cut off from any connection with the vault. The azygous area contains eight plates. The first one is in line with the first primary radials and fully as large. It is followed by three large plates, subequal in size, in the second range, and these by three small plates, in the third range, that are surmounted by a single plate in the fourth range that unites with two plates belonging to the vault.

The vault is somewhat elevated over the ambulacral openings, and convex toward the center, which bears a proboscis, that is broken off in our specimen just above the summit. It is covered with numerous, convex, polygonal plates, some of which bear central nodes. We are unable to discover any ovarian pores. It is probable, that, in some species, the ovarian pores were on the sides of the arms near the calyx, if the pores are correctly named. We know, that in some genera, as in *Dolatocrinus*, they vary in their places of exit from interradially on the vault to the base of the arms, and we see no reason why the channels may not have been carried up the ambulacral furrows one or more plates beyond the commencement of the free arms.

This species is distinguished by its general form, by having only eighteen arms, three regular interradials cut off from the vault and eight azygous plates, the last one connecting with the vault. These peculiarities do not exist in any other described species. It is probably as closely related to *B. labellum*, from the Keokuk Group, as to any other species, though a glance will distinguish them on account of the general form and surface of the plates, beside the interradiar areas are not alike, and, in that species, the azygous area is cut off from the vault, and in this species it is connected with the vault.

Found by Dr. M. N. Elrod in the St. Louis Group, at Lanesville, Indiana, and now in the collection of Wm. F. E. Gurley.

## BATOCRINUS JESSIEÆ, n. sp.

*Plate I, Fig. 27, azygous view of a specimen with basals and part of first radials broken off; Fig. 28, summit of same; Fig. 29, basal view of same specimen; Fig. 30, lower part of the calyx of what is believed to be another specimen; Fig. 31, azygous view of what is supposed to be a cast of the same species; Fig. 32, basal view of the cast.*

Species medium size. Calyx somewhat bell-shaped, truncated below, cylindrical, in the region of the first primary radials, and then rapidly expands to the free arms and is deeply notched in the interradian areas. The secondary radials project horizontally beyond the interradian areas. The plates are plain and smooth. Column round and small. Columnar canal minute.

The basals are about twice as wide as high and form a low cup slightly beveled at the basal sutures and having a small basal rim. It bears an hemispherical depression, radiately lined, for the insertion of the column. The diameter of the column is about half the diameter of the basal disc. The first radials are about as long as wide, three hexagonal and two heptagonal. They stand nearly vertical on the basals and form a round cylinder. Second radials comparatively very small, quadrangular, from one-half wider to twice as wide as high. Third primary radials of unequal size, larger than the second primary radials, three heptagonal, one hexagonal, one pentagonal, axillary and each bears on each superior sloping side two secondary radials. Each second secondary radial, in four of the rays, is channeled by two ambulacral furrows, which gives four ambulacral openings to the vault, in each of these rays, without the existence, apparently at least, not only as shown by the specimen preserving the plates but by the cast also, of any tertiary radials. In the ray opposite the azygous area there are also two secondary radials (only one is shown in the illustration, because the other is broken off from the specimen), but there are only two ambulacral openings to the vault. There are, therefore, eighteen ambulacral openings to the vault in this species.

All of the interradian areas connect with the vault. In each regular interradian area there are five plates. One of moderate size in the first range, two small ones in the second range and two elongated plates in the third range that curve over between



the secondary radial plates and connect with the plates of the vault. There are eight or more plates in the azygous area. The first one is in line with the first primary radials and of about the same size. It is followed by a range of three plates and above the plate on the left there is a small intercalated plate, and, above these, there are three plates that connect with the plates of the vault. In fact, they interlock with the plates of the vault so that there is no distinct line between the plates of the calyx and those belonging to the vault. There is also a minute plate intercalated above the second range on the right, as shown on the specimen preserving the plates, but it is not indicated on the cast. There is a little difference, in the upper part of the azygous areas, between the cast and the specimen having the plates, and the cast indicates nine plates in the area; but, on the whole, we think the cast belongs to this species.

The vault is convex and is covered with convex polygonal plates and bears a central proboscis that is broken off from our specimens. The cast shows the ambulacral channels are flattened on the superior side, but have a depth equal to the flattened diameter. The ambulacral openings are within the margin of the stellate projections of the radials and appear to be directed upward, notwithstanding that the lower side of the radials is projected horizontally, and the cast shows the ambulacral openings to be directed horizontally.

This is a very distinct and peculiar species that can hardly be compared with any other. It would seem to be as near *B. astericus* as to any other species, though that species has twenty arms, rounded basals, and altogether different regular areas and azygous area.

Found by R. A. Blair, in the Burlington Group, at Sedalia, Missouri, and now in the collection of S. A. Miller. The specific name is intended as a compliment to the accomplished daughter of R. A. Blair, who has assisted her father so much in collecting and making known the fauna of the Chontean and Burlington Groups of Missouri.

## BATOCRINUS SOLITARIUS. n. sp.

*Plate II, Fig. 8, side view; Fig. 9, azygous view; Fig. 10, summit of same specimen, part of the vault is gone; Fig. 11, basal view of same, part of the flange is broken off of the basal plates.*

This species is above medium size, somewhat urn-shaped or lanterniform, and possesses remarkably large flanging basal plates, such as have been made a generic character for *Eretnocrinus*, but more than half of the vault is preserved and there is no evidence of a proboscis, or even of an azygous orifice, though the plates are preserved from the azygous side straight back to a small, convex, central plate, shown in figure 10. The calyx is very broadly truncated at the base and expands but little and very gradually above. The diameter is about one-fourth more than the height. The radial series are more prominent than the interradial areas, in consequence of which, the latter appear to be somewhat flattened. The plates are either convex or nodose. The column appears to have been comparatively small.

The basal plates form a thin, broad, concave disc, the depth of the concavity is nearly equal to their height, and, in the center of the concavity, there is a concave depression for the insertion of the small column. The first primary radials are unequal in size, from two to three times as wide as high, each bears a transverse, cuneiform node, three hexagonal, two heptagonal. Second primary radials about three times as wide as high, quadrangular. Third primary radials one-half larger than the second, nodose, pentagonal, axillary, and support on each upper sloping side two secondary radials, the last ones of which are axillary and support on each upper sloping side two tertiary radials. This is the structure of two rays and of one-half of each of two other rays, one of which is opposite the azygous area, we believe, therefore, that all of the rays are substantially alike and that the species bears twenty arms and twenty ambulacral openings to the vault.

None of the interradial areas connect with the vault. In the regular interradial areas there are three plates, one large nodose plate followed by two small ones. In the azygous area there are seven plates, the first one is in line with the first primary radials and nearly as large, it is followed by three plates, in the second range, and three plates in the third range, which are cut off from the vault by the union of the tertiary radials above them.

More than half of the vault is preserved in our specimen. It is elevated over the arm openings and gently convex centrally. The plates are polygonal, the smaller ones convex, and the larger ones nodose. The central plate is nodose, and surrounded by seven plates. The plates are preserved from the central plate to the middle of the azygous area and there are no indications of an orifice or proboscis. Evidently there is no proboscis, in the species, and if an orifice, it was, in our specimen, out of the normal position. No ovarian pores are visible.

This is a peculiar species so different in form and all specific characters from others that no comparison is necessary to be made with any of them.

Found by C. S. Hodgson, in the Burlington Group, in Adams county Illinois, and now in the collection of S. A. Miller.

AGARICOCRINUS HODGSONI, n. sp.

*Plate I, Fig. 17, basal view; Fig. 18, summit view; Fig. 19, azygous side view; Fig. 20, view opposite the azygous area.*

Species robust and medium or above medium size. Calyx slightly convex in the lower part, but depressed in the region of the third radials. Outline ovate. Plates thick, more or less convex, and part of them subspinous. Arm openings directed below a horizontal line.

Basals form an hexagonal disc about one-half wider than the diameter of the column, that contains a moderately concave depression, radiately lined near the margin for the attachment of the column. The columnar canal is small and cinquefoil. The first primary radials are the largest plates in the calyx, a little wider than long, three hexagonal, two heptagonal. All of them are sculptured, so as to be pyramidal, the apices extending below the basals so that a specimen laid upon a table will rest upon these plates and the point of the first azygous plate. Second primary radials, quadrangular, transversely convex, about three times as wide as long. Third primary radials very little, if any, larger than the second, transversely convex, pentagonal, axillary, and, in three of the rays, support on each upper sloping side two secondary radials, which gives to each of these rays two arms. On the distal side of each third primary radial adjoining the azygous area there are two secondary radials, and on the proximal side a single secondary radial, which is axillary and supports upon the distal superior sloping side a single tertiary radial, and on the prox-

imal side two tertiary radials, which gives to each of these rays three arms. There are, therefore, in this species twelve arms. The last tertiary and secondary radial, in each series, is highly convex and the convexity extends below that of the secondary radial and third primary radial below it, which leaves a circular depression between the first primary radials and the last secondary and tertiary radials. The margin of the calyx thus seems to hang down and the ambulacral openings are exposed, in a basal view, while they cannot be seen in a summit view.

There are three plates in each regular interradial area, the first one rests between the superior sloping sides of the first primary radials and extends up between the first secondary radials. It is followed by two narrow elongated plates that connect with two plates belonging to the vault. The first azygous plate is in line with the first primary radials, nearly as large and heptagonal. It is followed by three plates in the second range, the middle one being the larger and extending to a plate belonging to the vault. On each side of the superior end of this middle plate there is an elongated narrow plate abutting the first tertiary radial and extending to the plates of the vault. There are, therefore, six plates in the azygous area belonging to the calyx.

The vault is only moderately convex, and is covered with large, polygonal, tumid plates that hang over the margin so as to hide the ambulacral openings from a summit view. At the margin of the azygous area there is an elliptical, bulbous prominence that shows no indication of having an orifice, from an azygous side view; but on the top of it there is a small opening partly surrounded by small plates. The orifice is irregular and an examination of it leads to the inference that it was covered by small plates. Indeed, there can be little doubt about it; and, if the orifice was not closed, by small plates, it was minute and not the kind one would expect to find in such a robust species.

This is a strongly marked species, so different, in all aspects, from those hitherto described, that no comparison will aid in distinguishing it.

Found by C. S. Hodgson, in whose honor we have proposed the specific name, in the Burlington Group, in Adams county, Illinois, and now in the collection of S. A. Miller,

## AGARICOCRINUS ILLINOISENSIS, n. sp.

*Plate I, Fig. 21, basal view: Fig. 22, summit view; Fig. 23, azygous side view.*

Species medium or rather below medium size. Calyx very low, moderately concave in the region of the basals and first primary radials, then gradually rounds over on the radial series, which are produced nearly on a level, while the plates curve up in the interradial areas. The concavity at the place of attachment of the column is about on a level with the dorsal side of the last secondary radials. The outline of the calyx is pentagonal with slightly concave sides for the depressed interradial areas. Plates thick, smooth or granular. Ambulacral openings elongated, directed upward and not visible in a basal view. Column medium size.

Basals form an hexagonal disc that is nearly or quite covered by the column. The first primary radials are elongated, transversely concave to correspond with the basal concavity, three hexagonal and two heptagonal. Second radials much smaller than the first, quadrangular, and from one-half wider to twice as wide as long. Third primary radials shorter and wider than the second, pentagonal, axillary, and support on each upper sloping side three secondary radials, the last one of which commences the double series of arm plates, but the inner half connects with a plate belonging to the vault that separates the ambulacral canals, and, therefore, does not belong to the free arms. There are only ten arms in this species, and ten arm openings to the vault. The arms evidently consist of the usual double series of plates united by a zigzag suture.

There is one regular interradial in each area. It is elongated and has nine sides. It rests between the short superior lateral sides of the first primary radials, separates the primary and secondary radials and connects its superior, narrow elongation, by a short truncated end, with a plate belonging to the vault, midway between the arms, at the top of the calyx. The first azygous plate is in line with the first primary radials and of the same general form, though longer and narrower, and of course heptagonal. It is followed by three plates, in the second range, the lateral ones are short and heptagonal, the middle one is elongated, hexagonal and unites its superior truncated end, with a plate belonging to the vault, midway between the arms, at the top of the calyx. The vault is low, most convex centrally, and the pentagonal outline, at the margin,



becomes obsolete toward the center. The capacity of the vault is less than that of the shallow calyx. The vault bears a rather large, convex, central plate and is otherwise covered with small and less convex polygonal plates. The large tumid plates that usually extend from the arms to the summit in this genus, do not characterize this species. The azygous orifice is not elevated or situated on a tumid swelling, as is usual in this genus, but is surrounded by small plates and a short side of the large central plate.

The depressed, short body, pentagonal outline of the calyx, small plates of the vault, single interradians, four azygous plates and ten arms are features that distinguish this species from all others. There is no described species, from the Burlington Group, with which it can be said to have much resemblance, but in its short body and general form it partakes of the character of *A. blairi*, from the Chouteau limestone, though the latter has only nine arms, is subquadrate in outline, and has more plates in the azygous and regular areas than this species has. It cannot be mistaken for any other described species.

Found by C. S. Hodgson, in the Burlington Group, in Adams county, Illinois, and now in the collection of S. A. Miller.

AMPHORACRINUS BLAIRI, n. sp.

*Plate I, Fig. 45, basal view; Fig. 46, same magnified two diameters; Fig. 47, summit view; Fig. 48, same magnified two diameters; Fig. 49, azygous side; Fig. 50, same magnified two diameters. It will be observed that one of the rays adjoining the azygous area is injured, so it is not shown in the illustrations.*

Species very small. Calyx broadly rounded below, bowl-shaped, or somewhat hemispherical. About twice as wide as high. Surface of test granular. No radial ridges.

Basals form an hexagonal disc one-half wider than the diameter of the column. First primary radials about as long as wide, three hexagonal, two heptagonal. Second primary radials smaller than the first, a little wider than long, hexagonal. Third primary radials somewhat smaller than the second, pentagonal, axillary and support on each upper sloping side a single secondary radial, which gives to each ray two arm openings to the vault. There are, therefore, ten arms in this species. The secondary radials are directed horizontally



and stand out their full length from the interradian areas. The cast shows only a single secondary radial but the test preserves two before the arms are fairly free.

The first regular interradian is larger than a second primary radial, hexagonal, and followed by two somewhat smaller plates in the second range, and by two still smaller ones in the third range, that separate the first secondary radials and unite with the plates of the vault. The first azygous plate is in line with the first primary radials and quite as large. It is followed by three plates in the second range, four in the third range, and two in the fourth range, that unite with the plates of the vault.

The vault is quite evenly convex, covered with polygonal plates, and bears a submarginal azygous orifice.

There is no described species very closely resembling this one and, therefore, no comparison with any of them is necessary to distinguish it.

Found by R. A. Blair, in the Burlington Group, at Sedalia, Missouri, and now in the collection of S. A. Miller. The specific name is in honor of the collector. After the illustrations were drawn from a cast, we received a specimen preserving the plates, from F. A. Sampson, of Sedalia, but as the plates are small and not ornamented the illustrations are about the same as if drawn from the test itself.

MEGISTOCRINUS INDIANENSIS, n. sp.

*Plate II, Fig. 1, basal view; Fig. 2, summit view; Fig. 3, azygous side view. Some of the sutures are obscure and are not shown in the illustrations.*

Species large. We have a specimen one half larger than the one illustrated. The capacity of the vault in some specimens is greater than that of the calyx. Calyx broadly basin shaped, slightly concave about the basal plates, from two and a half to three times as wide as high, not constricted below the arms but continuing to expand as far as the free arms, which are directed nearly horizontally or upward at an angle of less than twenty degrees. Surface ornamentation of the plates not preserved in any of our specimens. Column moderate size and having a large, slightly cinque foil canal.

Basal plates form an hexagonal disc about one-fourth wider than the diameter of the column. The first primary radials are unequal in size; those abutting a single basal are hexagonal,

and those abutting on two basals heptagonal. They are not visible in a side view. The second primary radials are as large as the first, hexagonal, and differ considerably in size. The third primary radials are also unequal in size, as large as the first or second, three heptagonal, two hexagonal, axillary, and, in the ray on each side of the azygous area and in the ray opposite the azygous area, bear on each upper sloping side a single secondary radial, which is axillary, and supports on each upper sloping side two tertiary radials, which gives to each of these rays four arms. In one of the lateral rays the third primary radial bears upon each upper sloping side three secondary radials, which gives to it two arms. In the other lateral ray, the third primary radial supports, on one superior sloping side, three secondary radials, and on the other a single secondary radial, which is axillary and supports on each upper sloping side two tertiary radials, which gives to it three arms. There are, therefore, seventeen arms and seventeen ambulacral openings to the vault in this species.

In each regular interrarial area there are eight plates, the first one is hexagonal, rests between the upper sloping sides of the first primary radials, separates the second primary radials and is followed by two plates nearly as large in the second range, three in the third range and two in the fourth range, that separate the arms and unite with the plates of the vault. There is one plate in each of the intersecondary radial areas that connects with the vault, except in the two-armed lateral ray where the secondary radials unite. The azygous area is large and contains twenty-one plates. The first one is in line with the first primary radials and of the same size, it is followed by three somewhat smaller plates, in the second range, five plates, in the third range, five plates, in the fourth range, four plates, in the fifth range, and three plates, as near as can be determined, in the sixth range, that unite with the plates of the vault.

The vault is broadly convex over the central part and ambulacral channels and depressed toward the margin in the interrarial areas. There is a small spine bearing plate in the center of the vault, and one over the junction of the ambulacral channels in each of the five radial series. The plates are small and the sutures too indistinct, over part of the vault of our specimens, to distinguish them. The azygous orifice is large, surrounded with numerous plates and subcentral. It

was slightly elevated, but the summit is injured in all of our specimens. There are no ovarian pores shown, in any of our specimens.

This is the only species of *Megistocrinus* bearing seventeen arms so far as known, and, therefore, need not be compared with any other to distinguish it. It would seem to be most nearly related otherwise to *M. expansus*.

Found by Geo. K. Greene, in the Hamilton Group, near Charleston, Indiana, and now in the collection of Wm. F. E. Gurley.

STEGANOCRINUS SPERGENENSIS, n. sp.

*Plate II, Fig. 4, azygous view; Fig. 5, opposite view; Fig. 6, basal view; Fig. 7, summit view.*

Species medium or above medium size. Calyx obpyramidal, rather broadly truncated, pentagonal, and stelliform, as seen from above, in consequence of the horizontal, rigid extension of the five radial series. The abrupt, horizontal extension of the radial series commences at the top of the third primary radials, which commence curving outward from the calyx, while the interradian areas begin to curve gently in, toward the vault. Plates thick, very nodose and pyramidal. They are sculptured so as to depress the angles of the plates. Column large and round.

Basals form an hexagonal cup, more than twice as wide as high. Plates stand upright, and each extends a cuneiform end below the end of the column. Each plate is more than twice as wide as high and longitudinally furrowed on the surface, and the sutures are beveled. The first radials are the largest plates in the body, and each one is furrowed from the central node toward the angles and the basal plates below. A little longer than wide, three hexagonal, two heptagonal. Second primary radials less than half as large as the first, sculptured in like manner, wider than long, and hexagonal. Third primary radials a little smaller than the second, curve outward so as to sharpen the angles of the pentagonal calyx. heptagonal axillary, and support on each upper sloping side a single secondary radial which is axillary and supports on each upper sloping side the tertiary radials. The tertiary radials are preserved as far as the third plate, in our specimen, and to this extent and doubtless for several plates beyond they are consolidated in each series so as to leave no free arms. The two third radials

in the middle of each series are axillary and bear quaternary radials. There are, therefore, thirty arms and thirty ambulacral openings to the vault in this species, as shown by our specimens.

The interradial areas all graduate up into the vault and over the ambulacral channels so as to leave no evidence of any dividing line between the vault and calyx. In the regular areas, one large plate is followed by two, in the second range, three, in the third range, and five, in the fourth range, that connect with the plates of the vault. In the azygous area the first plate is in line with the first primary radials and like them, except somewhat smaller. It is followed by two plates, in the second range, three, in the third range, five, in the fourth range, and eight, in the fifth range that connect with the plates of the vault. This area is very wide between the projecting radial series.

The vault is elevated over the ambulacral channels so that a transverse section of the radial series is subquadrate. It is convex toward the center where it bears a proboscis. It is covered with convex, polygonal plates of very unequal size. No ovarian pores have been detected.

This species is from rocks of a higher geological range than any heretofore described, but a true *Steganoerinus*, however, distantly related to other species.

Found by Dr. M. N. Elrod, in the St. Louis Group, at Spergen Hill, Indiana, and now in the collection of Wm. F. E. Gurley.

#### STROTOCRINUS ORNATUS, n. sp.

*Plate II, Fig. 12, azygous view; Fig. 13, right lateral view; Fig. 14, summit view.*

Species rather below medium size, as shown by our specimens. Calyx moderately truncated below, obconoidal as high as the top of the third primary radials, and then abruptly expanded, in the form of a flattened rim, that cuts off all connection of the interradial areas with the vault, as is usual in this genus. Primary radials transversely nodose, interradials nodose, and surface of all of them radiately sculptured; above the primary radials, the radial ridges are somewhat angular at first but rounded above.

Basals wider than high, stand upright, deeply beveled at the sutures and each extends a cuneiform end below the point of the columnar attachment. First primary radials about as

long as wide, three hexagonal, two heptagonal. Second primary radials about two-thirds the size of the first, hexagonal, and nearly as long as wide. Third primary radials almost as large as the second, hexagonal, axillary, and support on each upper sloping side a single secondary radial, which is axillary, and, in two of the rays, one of which adjoins the azygous area, and the other a lateral ray on the same side, bears upon each proximal side a single tertiary radial and upon each distal side two tertiary radials, which gives to each of these rays four arms. In the other three rays the distal side of each secondary radial bears two tertiary radials and the proximal side bears a single tertiary radial which is axillary and bears upon each superior sloping side a quaternary radial, which gives to each of these rays six arms. There are, therefore, twenty-six arms in this species.

There are, in each of four of the regular interrarial areas, seven plates, one in the first range, two in the second, two in the third, and two in the fourth. In the other area there are eight plates. The last four plates are very small. In the azygous area there are eleven plates. The first one is in line with the first primary radials and about the same size. It is followed by two plates, in the second range, three, in the third, three, in the fourth, and above these, there are two very small plates. The three plates, in the fourth range, are much smaller than those in the third range. There are no inter-secondary plates.

Vault moderately convex, composed of numerous convex, polygonal plates, and bears a small nearly central proboscis.

In describing this genus Meek & Worthen (5 Ill., 347,) included as typical *S. perumbrosus* and *S. liratus* and showed that they had the structure of *Actinocrinus*, "Up to the division of the rays, but with the body comparatively long and narrow below, and the secondary and other succeeding supplementary radials, brachial and intermediate pieces, connected laterally all around, and spreading out horizontally far beyond the limits of the body so as to form, with the flat or much depressed vault, a broad, more or less distinctly ten-angled disc, from the margins of which the numerous long, slender arms arise, without bifurcating after becoming free." It will be seen that this arrangement cuts off the interrarial areas from the vault and presents a structure of the calyx above the third radials fundamentally different from that of *Actinocrinus*. They said further that:



"Some of the species, such as *S. perumbrosus*, have but a very small simple opening situated subcentrally, or more or less excentrically toward the anal side, and penetrating the flattened vault obliquely, so as to be directed forward or away from the anal side; while others, like *S. liratus*, have a long erect, subcentral tube, or so-called proboscis, sometimes recurved at the end."

Wachsmuth & Springer proposed to divide this genus and make *S. liratus* the type of a new genus which they called *Teleocrinus*, which differs from *S. perumbrosus*, in no other respect, than that pointed out above by Meek & Worthen. In other words the genus *Teleocrinus* is to be distinguished from *Strotocrinus*, upon the elevation of the azygous opening. If the opening is at the top of the vault it is *Strotocrinus*, but if it is elevated the height of a plate it is *Teleocrinus*; and so if it is elevated one-fourth of an inch or half an inch, or an inch or more it is still *Teleocrinus*. This method of nomenclature we do not approve. We have shown, elsewhere, that the presence or absence or form of a proboscis, in *Batocrinus*, is not of generic importance and the same is true throughout the *Actinocrinidae*. The genera must be distinguished by the calyx. Therefore, after having given the subject our best consideration, we conclude that *Teleocrinus* must be regarded as a synonym for *Strotocrinus*.

The species here under consideration is a *Strotocrinus*, as the genus was defined by Meek & Worthen, and the simple fact that it has a small proboscis will not take it out of that genus. It is the only species thus far defined having twenty-six arms and will be readily distinguished from all others by the arm formula and inferradial areas.

Found in the Burlington Group, near Burlington, Iowa, and now in the collection of S. A. Miller.

#### ACTINOCRINUS JESSIE.E. n. sp.

*Plate II, Fig. 15, azygous side; Fig. 16, opposite view.*

Species large. Calyx obconoidal, regularly expanding from the column, about one-fourth wider than high. Surface beautifully sculptured so as to make each plate more or less obpyramidal from a central node. No radial ridges. Column not large.

Basals form an expanding cup, they project a little below the point of columnar attachment with the margins notched so as to form a trilobed base, which is concave for the attach-



ment of the column, and the top is one-half wider than the diameter at the base. The plates are about twice as wide as high, and the sutures are broadly beveled. A delicate angular ridge extends from the bottom of each plate to the middle of each side of the adjoining radials. First primary radials the largest plates in the calyx, a little wider than long, three hexagonal, two heptagonal. The central node is high, transverse, and from it a delicate angular ridge radiates to the middle of each side of each adjoining plate. When viewed from below these high, transverse nodes obscure the view of the plates above. Second primary radials about half as large as the first and ornamented in the same way. The one on the left of the azygous area is pentagonal, the others are hexagonal. The third primary radials are smaller than the second and ornamented in the same way. Three are hexagonal, one heptagonal and one pentagonal. The heptagonal plate and one of the hexagonal plates are truncated, at the summit, by an inter-secondary plate. In the other areas the inter-secondary plates do not abut upon the third primary radials. They are axillary and support on each superior lateral side a single secondary radial, which is ornamented like the radials below, and is axillary and supports on each upper sloping side a single tertiary radial. The tertiary radials are also ornamented like the radials. This is a feature common to every plate in the calyx, except the nodes become more pointed and less transversely elongated as they approach the free arms. There are, therefore, twenty arms and twenty ambulacral openings to the vault in this species.

All the interradial and intersecondary areas connect their plates with the plates of the vault. In the intersecondary areas there are two narrow plates, one following the other, the last one extending to the vault. The number of regular inter-radials varies in the different areas from five to seven. In an area having five plates there is one plate in the first range, two in the second, one in the third and one in the fourth. In another area having six plates, there are two plates in the third range, and in an area having seven plates, there are two plates in the third range and two in the fourth range. In the azygous area there are nine plates. The first one is in line with the first primary radials and about as large. It is followed by two plates in the second range, two in the third

range, then one small sunken square plate and one nodose plate, and above these two plates that unite with the plates of the vault.

This species is distinguished by its general form and surface ornamentation from all other described species. It is again distinguished by having all the interradial and intersecondary radials connected with the vault, and bearing twenty arms. A basal view will distinguish it from all other species.

Found in the Burlington Group, at Sedalia, Missouri, by Miss Jessie Blair, an accomplished scholar and student of Geology, for whom we have proposed the specific name.

#### FAMILY POTERIOCRINIDÆ.

##### ZEACRINUS PECULIARIS, n. sp.

*Plate II, Fig. 17, azygous area on the left, specimen compressed;  
Fig. 18, opposite side of the same compressed specimen;  
Fig. 19, basal view of same.*

Species rather above medium size, and when not compressed elongate-elliptical in outline. Calyx very low. Columnar cavity rather deep. Surface finely granular. Column small, round and having a minute columnar canal.

Basal plates within the calyx, the hollow conical cavity being filled with the end of the column. Subradials have rather acute superior angles but they are not visible in a lateral view. First radials only a little wider than long, the inferior angles extend into the columnar cavity, the plates expand to the superior lateral angles and are truncated the entire width above for the support of the second primary radials. Three are pentagonal, and the two adjoining the azygous area are hexagonal. They are separated from the second primary radials externally by slightly gaping sutures. The second primary radials are a little shorter than the first, but wider as they continue the same rate of expansion possessed by the first as far as the superior lateral angles. Three are pentagonal, the one on the left of the azygous area hexagonal, and these four are axillary and support on each superior sloping side the secondary radials; but in the ray opposite the azygous area there are three primary radials, consequently the second one is quadrangular. It is about two and a half times as wide as long. The third one is smaller than the second, pentagonal, axillary and supports on the upper sloping sides secondary radials. In the ray on the

right of the azygous area there are three secondary radials in the proximal series and four in the distal series. Each lateral ray is constructed in the same way. In the ray on the left of the azygous area, there are three secondary radials, in the proximal series, and five in the distal series. In the ray opposite the azygous area there are four secondary radials in each series. The last secondary radial, in each series, is axillary. The proximal tertiary rays do not bifurcate. They are composed of subquadrate plates, thirty of which are preserved, in some of the rays, in our specimen, before they are broken off. The distal tertiary rays bifurcate, in four instances, on the sixth plate and in the other six rays on the fifth plate. This arrangement gives to each ray six arms, or thirty arms in the species.

In the azygous area there are five plates, the first truncates a subradial diagonally, separates the first primary radials and supports two plates above. The second truncates an angle of a first primary radial, instead of a subradial, as is usual in this genus. It is hexagonal, abuts the second and third primary radials on the left, the third azygous plate on the right and supports the fourth azygous plate. The third is smaller and abuts upon the first, second and third primary radials on the right. The fourth is the largest in the area and extends to the third secondary radials. The fifth presents a triangular face with the superior angle as high as the summit of the first tertiary radials.

This species is distinguished by the shape of the body, number of secondary radials, thirty arms, and peculiar azygous area. It cannot be mistaken for any other species.

Found by Prof. A. G. Wetherby, in the Kaskaskia Group, in Pulaski county, Kentucky, and now in the collection of Wm. F. E. Gurley.

ZEACRINUS DOVERENSIS, n. sp.

*Plate II, Fig. 20; azygous side view; Fig. 21, opposite view; Fig. 22, basal view. The specimen is slightly compressed laterally.*

Species medium size and elongate-elliptical in outline. Calyx truncated below. Surface granular. Column small, round, and having a minute central canal.

Basal plates within the calyx, the hollow conical cavity being filled with the end of the column. Subradials have an acute superior angle visible in a lateral view. First radials

nearly twice as wide as long, the lateral sides expand to the superior lateral angles, truncated the entire width above for the support of the second primary radials, from which they are separated externally by a slightly gaping suture. All are pentagonal. The second primary radials in four of the rays are shorter than the first, pentagonal, axillary, and support on the superior sloping sides the secondary radials. In the ray opposite the azygous area there are four primary radials, the second and third are quadrangular, but the third is only about half as large as the second, and the fourth is short, pentagonal, axillary and supports the secondary radials. In the proximal ray on the left of the azygous area and in one of the lateral rays on the same side there are three secondary radials, in the other eight rays there are four secondary radials. The last secondary radials are pentagonal, axillary, and support the tertiary radials. There are only four tertiary radials preserved in any of the rays in our specimen, and hence our specimen shows only twenty arms in the species. Possibly, the distal series in each ray may divide.

There are seven plates in the azygous area. The first one is pentagonal, rests between the superior sloping sides of two subradials and below the first primary radial on the right. The second truncates a subradial and is heptagonal. The third is heptagonal and abuts the two primary radials and one secondary radial on the right. The fourth is quadrangular, small, and rests on the second. The fifth is the largest plate in the area and rests between the superior lateral sides of the third and fourth plates. The sixth is smaller and rests on the fifth.

The seventh is a small, triangular plate at the top of the area, between the tertiary primary radials.

This species is distinguished by the general form, number of primary radials, in the ray opposite the azygous area, number of secondary radials, in the different areas, and by the number of plates in the azygous area. These characters will distinguish the species from all others.

Found by Dr. M. N. Elrod in the Kaskaskia Group, at Dover Hill, Indiana, and now in the collection of Wm. F. E. Gurley.

## ZEACRINUS KENTUCKIENSIS, n. sp.

*Plate II, Fig. 23, basal view, showing the inferior part of the azygous area; Fig. 24, view opposite the azygous area, the specimen is a little compressed.*

Species rather above medium size and when not compressed elongate-elliptical in outline. Calyx very low and columnar cavity deep. Surface finely granular. Column small and round.

Basal plates within the calyx, the hollow conical cavity being filled with the end of the column. Subradials have acute superior angles, but they are not visible in a side view, though they curve up out of the columnar cavity. First radials about one-half wider than long and form a rounded base upon which a specimen may be made to stand. The inferior angles extend slightly into the columnar cavity, the plates expand to the superior lateral angles and are truncated the entire width above for the support of the second primary radials, from which they are separated, externally, by a wide gaping suture. Each one of them is pentagonal. The second primary radials are much shorter than the first, four of them are pentagonal, axillary, and support on each superior sloping side the secondary radials; but in the ray opposite the azygous area there are three primary radials; the second one is short and quadrangular, and the third one is smaller than the second, pentagonal, axillary, and supports on each upper sloping side secondary radials. In one of the rays, on the left of the azygous area, and in one of the lateral rays, on the right of the azygous area, there are four secondary radials, and in each of the other eight series there are only three secondary radials. In the ray opposite the azygous area the proximal tertiary rays do not bifurcate, but the distal rays divide on the fourth plate, which gives to this ray six arms. In the ray on the left of the last one described, as may be seen in the illustration, the distal tertiary series bifurcate on the fourth plate and the distal ones, in the quaternary series, bifurcate on the fifth plate, which arrangement gives to this ray eight arms. The ray on the right of the azygous area is constructed like the last one described and bears eight arms. The other two rays are injured in the superior part, but as far as preserved, they are like the two last described. There is little doubt, therefore, that the species bears thirty-eight arms.



There are six plates in the azygous area. The first is elongated, pentagonal, rests between the superior sloping sides of two subradials and the inferior sloping side of the first primary radial on the right. The second truncates a subradial adjoins the two primary radials on the left, and the first and third on the right and supports the fourth above. It is a small hexagonal plate. The third is heptagonal and about the size of the second. The fourth and fifth plates rest on the second and third and are about the same size. The sixth plate is the largest plate in the area, triangular, and extends its superior angle to the lower side of the third tertiary radials.

This species is distinguished by its general form, by the number and structure of its thirty eight arms and by the six plates in the azygous area.

Found by Prof. A. G. Wetherby, in the Kaskaskia Group, in Pulaski county, Kentucky, and now in the collection of Wm. F. E. Gurley.

BARYCRINUS ELRODI, n. sp.

*Plate II, Fig. 25, azygous view; Fig. 26, basal view; Fig. 27, view opposite the azygous area.*

Species large and plates remarkably thick. Calyx rapidly expanded, broadly bowl-shaped, one-half wider than high. Plates very tumid and radiately sculptured so as to leave an angular ridge directed to the middle of the side of each abutting plate.

Basals form a low expanding cup. The column is large and covers the bottom of the basal cup. The columnar canal is very large and pentalobate. A furrow arises at the summit of each first primary radial and descending slowly widens and deepens to the lower surface of the basal cup. Subradials large nearly as long as wide, radiately furrowed toward each angle and toward the middle of the basal plates, so as to leave two angular ridges extending to the basal plate below and one to the middle of each side of the adjacent plates. First radial the largest plates in the calyx, wider than high. Two rounded ridges arise at the lower edge of the facet for the second radials on each plate and extend to the middle of the adjacent sides of the subradials. The plates are arcuately depressed laterally so as to leave the lateral sutures at the bottom of the furrow or concavity. There is a broad, concave facet, extending nearly the entire width of each plate and depressed out-



wardly, at an angle of about forty degrees below a horizontal line, for the second radials. The superior lateral sides come together, at the sutures, so as to form a slight angle.

The first azygous plate broadly truncates a subradial. It is subquadrate in outline, but slightly expands upward. It is a little wider than high.

The general form, low basals, single azygous plate, thick plates and surface ornamentation readily distinguish this species from all others.

Found by Dr. M. N. Elrod, in whose honor the specific name is given, in the St. Louis Group, at Spergen Hill, Indiana, and now in the collection of Wm. F. E. Gurley.

POTERIOCRINUS PULASKIENSIS, n. sp.

*Plate III, Fig. 26, azygous side; Fig. 27, opposite side, showing two plates, in two of the arms, above the first radials.*

Species medium size. Calyx broadly truncated, and conoidal above or like the frustum of a cone. Plates convex and sutures depressed, at the angles, and a pore penetrates the calyx, at every angle, in the same manner that they do in *P. broad-headi*; though then do not seem to be any pores between the angles as in that species. Diameter a little more than the height.

Basals short and truncated by the column. Subradials large and about as long as wide, three hexagonal, two heptagonal. First radials about one-fourth wider than long, truncated the entire width above and separated from the second plates by a gaping suture. Second radials short. Third radials in the two rays opposite the azygous area short and axillary. Indicating that there are ten arms in this species.

The first azygous plate is nearly as large as a subradial, rests between the superior sloping sides of two subradials, separates two first radials and supports the second and third azygous plates which makes the plate hexagonal, though only slightly truncated by the third azygous plate. The second azygous plate is only a little more than half as large as the first. The third plate is not preserved in our specimen.

This is an extraordinary species that does not require a comparison with any other for the purpose of distinguishing it.

Found by Prof. A. G. Wetherby, in the Kaskaskia Group, in Pulaski county, Kentucky, and now in the collection of Wm. F. E. Gurley.

## FAMILY DOLATOCRINIDÆ.

## DOLATOCRINUS INDIANENSIS, n, sp.

*Plate III, Fig. 1, basal view; Fig. 2, summit view, azygous side on the left; Fig. 3, azygous side view.*

Species large. Calyx subhemispherical, very broadly truncated and slightly concave on the lower side, and constricted below the arms. Very small radial ridges. Central nodes small on the radial ridges and inconspicuous or obsolete on the other plates. Radiating lines from the central part of each plate numerous, but small. Column round and having a large cinquefoil columnar canal that occupies more than half its diameter.

Basal plates form a pentagonal disc a little depressed below the central part of the surrounding radials and having a diameter about one third more than the diameter of the column. First primary radials from one-third to one-half wider than long and subequal in size. Second primary radials nearly twice as wide as long, quadrangular. Third primary radials expand slightly to the superior lateral angles. They are nearly twice as wide as long, pentagonal, axillary, and in the rays on each side of the azygous area and in the ray opposite the azygous area bear upon each superior sloping side a single secondary radial, which is axillary and bears upon each upper sloping side a single tertiary radial, which gives to each of these rays four arms. In one of the lateral rays the third primary radial bears upon one superior sloping side two secondary radials and upon the other a single secondary radial, which is axillary and bears upon each upper sloping side a single tertiary radial. This ray, therefore, has three arms. In the other lateral ray the third primary radial bears upon each upper sloping side two secondary radials that give to it two arms. There are, therefore, in this species seventeen arms, and seventeen ambulacral openings to the vault, all of which are directed upward.

The azygous area is like the other areas or so near like them that it is hard to distinguish any difference. The first interradials are the largest plates in the calyx, have nine sides, and are broadly truncated above for the second interradials. The second interradials are about, or less than, half as large as the first, and are followed by a single plate less than half as large as the second, and which unites with two elongated plates belonging to the vault.

The vault is slightly convex toward the central part and equally as much depressed in the interradial areas toward the margin. The plates are large, but the sutures are too indistinct, in our specimen, to allow the artist to trace them, besides, the surface is so eroded as not to preserve the surface ornamentation. The subcentral azygous orifice is excentric from the azygous side, which is well shown in figure 2 and presents a peculiarity rarely seen in a crinoid. There are twenty ovarian pores situated close to the ambulacral openings; one on each side of the double arm openings and one on each side of the single arm openings.

The arrangement of the arms, in this species, is different from that in *D. bellulus* and *D. aureulus*, where each of three rays bear three arms and the other two bear four arms each, beside important differences in form and surface ornamentation. These are the only species that have been described that bear seventeen arms, and it is quite unnecessary, therefore, to make further comparisons.

Found by Geo. K. Greene, in the Hamilton Group, near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

DOLATOCRINUS ARGUTUS, n. sp.

*Plate III, Fig. 4, basal view; Fig. 5, azygous side; Fig. 6, summit view.*

Species rather below medium size. Calyx bowl-shaped, sub-pentagonal, concave below; radial ridges broadly rounded; plates highly convex and slightly radiately ridged toward the margins. Column small and round.

Basal disc pentagonal, depressed; the basal plates are within the cavity of the calyx, in the form of a hollow cone, and the end of the column fills the hollow cone in the superior part, and leaves the basal disc, at the base of the cone, one-half wider than the diameter of the column. First primary radials about as long as wide, abruptly bent in the middle, the lower part forming part of the basal concavity and the superior part curving as abruptly upward. The central part of the plates are tumid rather than nodose and the calyx will rest on the tumid elevations. Second radials quadrangular, a little wider than long and sides nearly parallel. Third primary radials about twice as wide as high, rather smaller than the second primary radials, pentagonal, axillary and support upon each superior sloping side two secondary radials. The second sec-

ondary radials are smaller than the first and the arms in each radial series are drawn close together, leaving wide interrarial spaces. There are only ten ambulacral openings, in this species, and they are directed upward so as to be hardly visible in a side view. The second secondary radials are broken away from some of the rays in the specimen illustrated.

The first regular interradians are the largest plates in the body, except the first azygous plate, longer than wide, and have nine sides. They are most tumid at the upper third. The second regular interradians are about one-third as large as the first, heptagonal, and the two superior sides unite with two elongated plates belonging to the vault and the two short superior lateral sides unite with small plates that form part of the covering for the ambulacral channels. The azygous area is larger than the regular interrarial areas and the first plate is the largest in the body. It is followed by three plates in the second range, the two lateral ones being small and quadrangular, while the middle one is large and heptagonal. The lateral plates each abut upon a small plate that forms part of the covering of an ambulacral channel, and the middle one abuts upon two of these plates and upon two elongated plates that belong to the vault.

The vault is very slightly convex and is depressed in the interrarial areas and bears a short subcentral proboscis. It is covered by two circles of plates and two or three small intercalated ones. The plates appear to have been granular. There are ten ovarian apertures; one on each side of each pair of arms and near the ambulacral openings.

This species most resembles *D. bulbaceus*, but differs in form by being less globular, wider in proportion to its height, in having a shallower concavity below and less elevated vault. But the most distinctive difference is in the azygous areas. In *D. bulbaceus* the azygous area is like the regular areas and has only one plate, in the second range, while in this species the areas are very different, and there are three plates in the second range. In this species there are ten ovarian pores, and in that species none have been discovered. There is also some difference in the surface ornamentation, so that the two species cannot be mistaken for each other.

Found in the Hamilton Group, at Charlestown, Indiana, and now in the collection of Mr. J. E. Hammell, of Madison, Indiana.

## DOLATOCRINUS BELLARUGOSUS, n. sp.

*Plate III, Fig. 7, basal view; Fig. 8, side view, azygous area on the left; Fig. 9, summit view.*

Species below medium size and elegantly sculptured. Calyx hemispherical, truncated below, and expanding to the free arms. Radial ridges consist of small round ridges crossing the central part of the plates and bearing sharp, elongated nodes in the middle part of each plate. They are not transverse as in *D. bellulus*. The surface is ornamented with very numerous radiating lines that bear sharp small nodes. There are no central nodes on the interradials. Column round, medium size and bears a large cinque foil, columnar canal.

Basal plates form a pentagonal one-fourth wider than the diameter of the column, at the surface, and extend up into the calyx, in the form of a hollow cone, which is filled with the end of the column. First primary radials wider than long and subequal in size. Second primary radials from one-half wider to twice as wide as long, quadrangular. Third primary radials expand to the superior lateral angles, larger than the second primary radials, about one-half wider than long, pentagonal, axillary, and, in one of the rays, on the left lateral side, and, in the one on the right of the azygous area, bear upon each superior lateral side a single secondary radial, which is axillary and supports upon each upper sloping side two tertiary radials, which gives to each of these rays four arms. In each of the other three rays, the third primary radial bears upon one upper sloping side three secondary radials, and upon the other one secondary radial, which is axillary and supports upon each superior sloping side two tertiary radials. In the ray on the left of the azygous area, it is the proximal side of the third primary radial that bears only secondary radials, while the distal side bears the tertiary radials, which is contrary to the usual structure of crinoids. There are, therefore, three arms in each of three rays. The species has seventeen ambulacral openings to the vault, all of which are directed upward, though the last tertiary and secondary radials are directed outward so that each radial series extends above the interradial areas.

The azygous area is like the others except slightly wider between the arms. The first interradials are the largest plates in the calyx, have nine sides and are broadly truncated above for the second interradials. The second interradials are less



than one-fourth as large as the first and extend about to the top of the calyx. Each one is followed by a smaller plate that abuts, each side, against a small plate, that covers part of the ambulacral channel and in front unites with two elongated plates belonging to the vault.

The vault is very slightly convex, depressed in the inter-radial areas, toward the margin, so that each radial series stands out prominently and bears a short subcentral proboscis. The sutures between the plates are partly obliterated in our specimen, so the artist has not attempted to show any of the plates. There is a very small ovarian aperture close to the ambulacral opening on each side of each pair of arms and on each side of each single arm, which gives to the species twenty ovarian apertures.

This species differs from *D. bellulus*, which it most resembles, in many minor particulars and in some of specific importance. It is smaller, shorter in proportion to its width, the radial series stand out more prominently, at the summit, and the vault is less elevated. The nodes are longitudinally elongated on the surface of this species, and transversely elongated on *D. bellulus*, and the rest of the surface ornamentation quite as different, notwithstanding the resemblance in some particulars. In *D. bellulus* each of the arms adjoining the azygous area bears four arms, in this species the right one bears four arms and the left one three arms. In this species, the ray on the left of the series opposite the azygous area bears four arms, and the corresponding ray in *D. bellulus* bears only three arms. There are other differences but these are sufficient to distinguish the species.

Found by J. F. Hammell in the Hamilton Group, near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

DOLATOCRINUS CHARLESTOWNENSIS, n. sp.

*Plate III, Fig. 10, basal view; Fig. 11, summit view; Fig. 12, azygous side view.*

Species medium or above medium size and handsomely sculptured. Calyx subhemispherical or subcylindrical, broadly truncated at the base and constricted below the arms. Rounded radial ridges have more or less elongated nodes at the center of the plates. Small ridges radiate from near the center of the plates, but they do not commence at the nodes or radial ridges. A smooth space is left between the radial ridges and the com-



mencement of these radiating ridges, and the radiating ridges do not commence at a node on the interradial plates. The column is round and has a very large cinque foil columnar canal.

Basal plates form a hollow cone within the cavity of the calyx. The column fills the cone so that the diameter of the column is nearly equal to the diameter of the pentagonal basal disc. First primary radials nearly as long as wide and subequal, in size. Second primary radials quadrangular and nearly as long as wide. Third primary radials expand to the superior lateral angles. They are considerably larger than the second, pentagonal, axillary, and in one of the lateral rays bears upon each upper sloping side a single secondary radial which is axillary and bears upon each superior sloping side two tertiary radials which gives to this ray four arms. In the other lateral ray, the third primary radial supports upon each superior sloping side three secondary radials, which gives to it only two arms. In the rays on each side of the azygous area and in the ray opposite the azygous area, the third primary radial supports upon one of its superior lateral sides three secondary radials, and upon the other a single secondary radial, which is axillary, and supports upon each upper sloping side two tertiary radials, which arrangement gives to each of these three rays three arms. There are, therefore, fifteen arms, in this species. Upon the right side of the azygous area the third primary radial supports, upon its proximal side, three secondary radials; but on the left side of the azygous area, it is the distal side of the third primary radial, that supports the three secondary radials.

The azygous area is like the other interradial areas. The first interradials are pentagonal and much smaller than they generally are, in specimens of the same size, in this genus. They are broadly truncated above for the second interradials. The second interradials are about two-thirds as large as the first and are followed by a much smaller plate in the third range, that separates the arms and unites with two large and elongated plates that belong to the vault.

The vault is only slightly convex, and equally as much depressed, in the interradial areas, toward the margin. It is covered by two circles of plates and a few intercalated ones, the surface of which is covered with granules and small nodes. It bears a small subcentral proboscis which seems to be complete in the specimen illustrated. There is a small ovarian

aperture on each side of each pair of arms and on each side of each single arm, which gives to the species twenty ovarian apertures. Some of the sutures on the vault of our specimen are not distinct, and for that reason the artist has not drawn all the plates.

Only two species bearing fifteen arms have been heretofore described (*D. canadensis* and *D. triadactylus*) and they have so little resemblance to this species that it would be idle to make any comparison. It is, of course, unnecessary to compare it with any other described species, because the arm formula alone distinguishes it.

Found by J. F. Hammell, in the Hamilton Group, near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

DOLATOCRINUS CCELATUS, n. sp.

*Plate III, Fig. 13, basal view; Fig. 14, side view; Fig. 15, summit view, the sutures cannot be traced and hence the plates are not shown.*

Species below medium size and elegantly sculptured. Calyx hemispherical, rounding from below and expanding to the free arms. Sharp angular radial ridges bearing long sharp nodes, in the middle part of each plate. The surface is further ornamented by a long sharp node, in the central part of each first interradiar, and by numerous radiating lines from the central part of each plate, from two to four lines to each abutting plate. Column round, large, and having a large, cinque foil canal.

Basal plates form a pentagon, less than one-fourth wider than the diameter of the column at the surface, and extend up into the calyx, in the form of a hollow cone, which is filled with the end of the column. First primary radials a little wider than long, subequal in size, and the calyx will rest on the points of the central nodes on these plates. Second primary radials very little wider than long, quadrangular. Third primary radials not any longer than the second, expand to the superior lateral angles, pentagonal, axillary, and in three of the rays support on each upper sloping side a single secondary radial, which is axillary and supports on each upper sloping side two tertiary radials, which arrangement gives to each of these rays four arms. In the other two rays the third primary radials support on each superior sloping side three sec-

ondary radials, which gives to each of these rays two arms. There are, therefore, sixteen arms and sixteen ambulacral openings to the vault in this species.

The interradial areas are substantially alike. The area between the two armed rays is slightly more bulged than the other areas, and the first plate is somewhat larger than it is in the others, which indicates that it is the azygous area. The first interradials are the largest plates in the body, have nine sides, and are broadly truncated above for the second interradials. The second interradials are short and wide and the superior part curves in and unites with the plates of the vault.

The vault is only slightly convex over the central part and radial areas, and is very much depressed toward the margin, in the interradial areas, so that the radial areas stand up and project beyond the margin of the calyx and have the ambulacral openings directed upward. The plates over the junction of the ambulacral canals bear nodes and the other plates are tubercular, but our specimens show them somewhat eroded and the sutures between the plates can only be, in part, traced, and for those reasons these features are not shown in the illustrations. There are sixteen ovarian apertures, one close by the side of each ambulacral opening to the vault.

This species would seem to be more nearly related to *D. salebrosus*, than to any one hitherto described, but the base is depressed, in that species, and truncated and the vault elevated more than in this, so that they may readily be distinguished by the form. The surface ornamentation too is somewhat different in the two species, and so are the interradials, and in that species no ovarian pores have been discovered. But the arm formula alone is sufficient to distinguish them, and to separate this from all other described species. In *D. salebrosus*, the arm formula is  $4+4+3+3+2=16$ . In this species it is  $4+4+4+2+2=16$ . The azygous area in that species, if it has any, is between the four-armed rays, and in this between the two armed rays.

Found by Geo. K. Greene, in the Hamilton Group, near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

## DOLATOCRINUS APLATUS, n. sp.

*Plate III, Fig. 16, basal view; Fig. 17, summit view; Fig. 18, side view. The suture lines are too indistinct on the vault of our specimens for illustration.*

Species medium size, very short or much depressed, vault and calyx subequal in capacity. Calyx low, more than three times as wide as high, rounding out from a deep basal cavity and spreading, without any constriction, to the free arms. Surface deeply sculptured. Radial ridges very small but made somewhat conspicuous by the elongated nodes at the center of each plate.

Basal plates within the cavity of the calyx and extending as high as the base of the free arms. First primary radials are entirely within the basal concavity. Second primary radials short, quadrangular, two or three times as wide as high. Third primary radials, short, pentagonal, axillary and each supports on one of the superior sloping sides four secondary radials, and upon the other a single secondary radial which is axillary and bears upon each upper sloping side four tertiary radials, by which arrangement, there are three arms to each ray. There are, therefore, fifteen arms in this species, and fifteen ambulacral openings to the vault.

The azygous area is like the other areas. The first inter-radials are somewhat elongated, have nine sides and are broadly truncated above for the second interradials. Instead of a central node, on each plate, there is a central excavation, from the margin of which the plates are radiately sculptured. The second plate is about one-fourth as large as the first and it is followed by two small plates in the third range that unite with the plates of the vault.

The vault is subconical and bears a subcentral orifice at the summit. Probably the orifice might be said to be at the top of the proboscis, but the proboscis is not the sixteenth of an inch high, and hence, appears only as a slight elevation for the azygous opening. The sutures on the vault, in our specimens, are so badly obliterated that it is impracticable to attempt to describe the plates. There are four ovarian slits between each radial series, and two between each of the ambulacral openings, which arrangement gives to this species forty ovarian apertures.

This species is distinguished by its depressed form, peculiar, sculptured ornamentation, three arms to each radial series, and forty ovarian apertures. The slightest observation will enable any one to distinguish it from all other fifteen-armed species.

Found by Geo. K. Greene in the Hamilton Group, near Charlestown, Indiana, and now in the collection of Wm. F. E. Gurley.

#### FAMILY CYATHOCRINIDÆ.

CYATHOCRINUS WALDRONENSIS, Miller & Dyer.

*Plate III, Fig. 19, azygous view; Fig. 20, opposite view. The specimen is compressed laterally, and magnified two diameters.*

This specimen was described, in 1878, in "Contributions to Palæontology No. 2," page 6, from a specimen that did not show the interradians or azygous plates, and which was poorly illustrated on plate IV, Fig. 9, from a specimen then owned by the late C. B. Dyer. The species is extremely rare and we are glad to be able to refigure it, from a better specimen than the original, though it is the second specimen we have ever had the opportunity to examine.

Calyx forms a cup one half wider than the height, and having the basals sunk within the cavity of the calyx. Surface granular. Column small and round.

Subradials of unequal size, longer than wide and curving into the small columnar cavity where they abut upon the basals. The azygous one is larger than either of the others. The first primary radials are larger than the subradials and about twice as wide as long. The second primary radials are very short and quadrangular. The third primary radials are about the size of the second, pentagonal, axillary and support upon the upper sloping sides the free arms. There are, therefore, ten arms, in this species. Above the first two plates the arms are composed of a double series of interlocking plates. The arms are coarse, wide, and short.

A single interradian, in each area, curves in upon the vault. The azygous plate is longer than wide, truncates a subradial, stands nearly vertical and extends as high as the third primary radial.

The specimen here illustrated and described was found in the Niagara Group near Hartsville, Indiana, by Dr. M. N. Elrod and is now in the collection of Wm. F. E. Gurley.



## CYATHOCRINUS BLAIRI, Miller &amp; Gurley.

*Plate III, Fig. 21, azygous side view of an entire specimen;  
Fig. 22, summit view of the same specimen.*

The authors described this species last year in Bulletin No. 7 of the Illinois State Museum of Natural History, p. 67, and illustrated it on plate IV, figs. 11 to 15, but at that time, only the calyx was known. Since that time Mr. R. A. Blair has found a complete specimen which we are able to illustrate. If, from any cause, it was dwarfed, at the superior end, we are unable to detect it; for it appears to be normal.

The entire body with arms closed is spheroidal. The second radials are as wide as the first, very short and quadrangular. The third radials are nearly as wide as the second, short, pentagonal, axillary, and support on each upper, sloping side two secondary radials, which gives to the species ten arms. The secondary radials are not of uniform size, but they are so constructed and arranged as to cover the vault, seemingly, as close as vault plates would cover it, except a small round spot at the center, which looks like the azygous orifice. The depressions on the summit between the radial series, gives it a slight pentalobate aspect when viewed from above. The second azygous plate is semicircular with the arcuate side up and is so closely surrounded above the first plate, by the radials, that it looks like a plate forming part of the vault.

We have never before seen arms resembling those in this species, unless those in the *Ichthyocrinidae* might be said to have some similarity. The comparison, however, is remote. Even the calyx suggested that it might not prove to belong to *Cyathocrinus*, and that doubt is increased by this complete specimen. We do not, however, discover characters that we call generic, to distinguish it. It is a very singular species.

Found by R. A. Blair, in the Chouteau limestone, at Sedalia, Missouri, and now in the collection of S. A. Miller.

## FAMILY GLYPTASTERIDÆ.

## THYSANOCRINUS MILLIGANÆ, n. sp.

*Plate III, Fig. 23, basal view, the basal plates being in a pit and substantially hidden by the column; Fig. 24, azygous side; Fig. 25, opposite view.*

Species medium or above medium size. Calyx bowl-shaped, broadly truncated below and slightly expanded above. Pentagonal in transverse section or as seen from above or below. Plates thick and deeply sculptured. Surface granular. Column small.

Basals small, deeply sunken in the basal concavity so as to be hidden by the column. Subradials large. They bend into the basal concavity and up on the outside of the calyx, where the height appears to be nearly equal to the width. They terminate below in pyramidal points on which the calyx will rest, if placed on a table, and which extend laterally so as to give a pentagonal outline to the base of the calyx. First primary radials twice as wide as long and bear a subcentral transverse ridge, having raised lines directed to the angular ridges on the subradials below. Second primary radials short, quadrangular, five or six times as wide as long. Third primary radials a little larger than the second, pentagonal, axillary and bear upon each superior sloping side a secondary radial, which gives to this species ten arms.

There are three regular interradians in each area. The first one rests between the superior sloping sides of the first primary radials and bears a central elongated node. It is followed by two narrow elongated plates that curve over upon the vault. The first azygous plate is large, truncates a subradial and bears a large central node. It is followed by three plates, the middle one truncating it slightly. They curve over upon the vault.

Vault and arms unknown.

This species is quite different, in form and surface markings, from all other described *Thysanocrinus*, but it substantially agrees with the generic formula, so far as it is preserved, and we have, therefore, very little doubt about the generic reference.

Found by Mrs. J. M. Milligan, in whose honor we have proposed the specific name, in the Niagara Group, of Decatur County, Tennessee, and now in her collection.

## FAMILY ICTHTHYOCRINIDÆ.

## LECANOCRINUS GREENEI, n. sp.

*Plate III, Fig. 28, azygous side view of body, arms, and part of the column.*

Species medium size: general form, with the arms closed, obovate. Surface smooth or granular. Column composed of rather thick plates.

Basals form a low cup having a diameter at the top nearly one half greater than the diameter of the column and truncated below the full diameter of the column. Subradials large, nearly as long as wide and gradually expanding. First primary radials of unequal size and about twice as wide as long. Second primary radials short, quadrangular, one-third as large as the first, three or four times as wide as long. Third primary radials a little larger than the second, pentagonal, axillary, and bear upon each upper sloping side the secondary radials. The number of secondary radials is not uniform. In one of the rays shown in our specimen there are three secondary radials and in the other three rays there are four secondary radials, the last being axillary, which gives to the species twenty arms. Some of the arms probably bifurcate again.

There is an elongated, octagonal interradial plate on the right side of our specimen, resting between the superior sloping sides of a first primary radial and a second primary radial, and separating the primary radials and one secondary radial, on one side, from the second and third primary radials and the first and second primary radials, on the other. An interradial may be seen on the left side of the specimen that appears to occupy the same position. The azygous interradial broadly truncates a large subradial and separates the primary and first secondary and part of the second secondary plates, that abut against it, giving to it eleven sides. If there are two azygous plates in this species, as is usual in the genus, the suture, that separates one from the first primary radial on the right, is obliterated, in our specimen.

The regular interradials, in this species, constitute a marked peculiarity, the azygous plate too is different from all others. It may also be distinguished by its general form.

Found by George K. Greene, in whose honor the specific name is given, in the Niagara Group near Louisville, Kentucky, and now in the collection of Wm. F. E. Gurley.

## FAMILY SYNBATHOCRINIDÆ

## SYNBATHOCRINUS ILLINOISENSIS, n. sp.

*Plate III, Fig. 29, basal side view of Calyx; Fig. 30, azygous side view of same; Fig. 31, Summit view of same.*

Species from medium to large size. We have a specimen about two-thirds as large as the one illustrated. Arms unknown. Calyx truncated for a large column, broadly constricted in the middle part, where it is evenly rounded, and subpentagonal at the top, by reason of the straight, transverse, superior sides of the first radials. About twice as wide as high. Sutures slightly beveled. Surface granular.

Basals form a cup three times as wide as high, having a concave base for the attachment of a large column and a pentagonal outline above for the support of the straight inferior sides of the first radials. First radials one-third wider than high, gradually expand from the base to the top which is truncated the entire width, on three of the plates for the reception of the second radials. The other two plates are slightly truncated, at one angle, for the reception of the azygous plate. Three of them, therefore, are quadrangular and the other two pentagonal. The superior face of each plate is very deep and bears an angular node, at each internal angle, with a flange at the border of the internal cavity, notched at the middle for the ambulacral furrow. There is a straight furrow, half the width of the plate, just within the outer margin, for the articulation of a ridge on the second plate. The central cavity is pentalobate.

The general form of the calyx of this species readily distinguishes it from all heretofore described. The rounded and constricted body will alone suffice to separate it from all others. It is not practicable, therefore, to compare it with any other.

Found in the Burlington Group, in Adams county, Illinois, by C. S. Hodgson and now in the collection of S. A. Miller.

## FAMILY TAXOCRINIDÆ.

FORBESOCRINUS WASHINGTONENSIS, n. sp.

*Plate III, Fig. 32, azygous view of a specimen laterally compressed; Fig. 33, view, opposite the azygous area, of another specimen.*

Species medium size; plates highly convex; transverse sutures nearly straight in the calyx but becoming slightly arcuate toward the ends of the rays. Calyx constitutes two-thirds of the body. It is wider than high. The interradiat areas are slightly depressed so as to make the calyx obpyramidal above the truncated base. The arms rapidly contract above the calyx and are infolded at the ends. Column tapers rapidly below the calyx where it is composed of very short plates.

Basals sunk within the calyx. Subradials small, three heptagonal, two hexagonal. Primary radials four in each series, three or four times as wide as high; the last one is axillary and supports upon each upper sloping side three secondary radials, the last one of which is axillary and supports upon each upper sloping side tertiary radials. The secondary radials are as long as the primary radials, but not quite as wide. The tertiary radials vary in number, in the different rays, from four to nine. In the proximal series, on the left of the azygous area, there are eight plates, in the next series four; and in the proximal series, on the right of the azygous area, there are six plates, and in the next series five. In the ray opposite the azygous area the distal series have nine plates each and the proximal series have six in one and seven in the other. The number of tertiary plates vary, in like manner, in the other two rays. The last tertiary radials are axillary and the proximal rays do not divide, but each distal quaternary series bears an axillary plate and supports the fifth series on each of its superior sides. The number of quaternary plates in the various distal series varies from nine to twelve. There are, therefore, twelve arms to each ray, or sixty arms in this species.

The regular interradiat areas are long and narrow, and the plates vary in number in the different areas, as shown in our specimens, from twelve to sixteen. The first plate rests between the superior sloping sides of the first primary radials. It is succeeded by five ranges of two plates each, and above these there are from one to five single plates, one above the other, so that the last one extends up to the third or fourth tertiary radials. The intersecondary areas have from five to



seven plates. There is one rather large plate, followed by either one or two ranges of two plates each, and above these there are two or three plates, one above the other. There are no intertertiary radials. In the azygous area two plates truncate a subradial, which is more than twice as large as either of the other subradials. There are three plates in the second range, four in the third range, which is at the widest part of the area. Above the third range the plates are irregular in size and not placed in ranges, and number about twelve, the last one of which reaches to the second tertiary radials. The whole number is about twenty-one.

This species most resembles *F. speciosus* from the same locality; but, while this species is larger, it has not as many regular interradians, fewer secondary radials, and no intertertiary radials. The azygous areas are altogether different, and so also are the subradials, at the base of the areas. This species has sixty arms, while that species was described as having only forty. The transverse sutures, too, in that species, are much more arcuate than in this. The two species cannot be mistaken for each other.

Found in the Keokuk Group, in Washington County, Indiana, and now in the collection of Wm. F. E. Gurley.

FORBESOCRINUS MULTIBRACHIATUS, Lyon & Casseday.

Plate IV, Fig. 1, diagrammatic view, copied from Sidney S. Lyon's original drawing, by his son, Victor W. Lyon.

This species was not illustrated by the founders of it, though some drawings of it were made, and, as a natural consequence, other species have been confounded with it. The errors arising from the want of illustration evidences the imperative necessity of disregarding all definitions of species that are not accompanied with illustrations, where a later author has properly described and illustrated them. Where, however, as in this case, no one has made a synonym, it is eminently proper to illustrate the species, so that it may stand, as of the date of the publication, in the American Journal of Science and Arts, 2d Ser., Vol XXVIII, p. 235, in 1858. Sidney S. Lyon and S. A. Casseday wrote very full and accurate descriptions, and, for this further reason, it affords us pleasure to be able to furnish an authentic illustration of this species. It is very doubtful about there being any generic distinction between *Forbesocrinus* and *Tarocrinus*, and, hence, we find

this species sometimes referred to *Tarocrinus* and at other times to *Forbesocrinus*. And again it is doubtful which word has priority, in proper definition and illustration, though the name, *Tarocrinus* was first proposed. If both genera are to stand, we are inclined to think this species was correctly referred, by its author, to *Forbesocrinus*. The species described by White under the name of *Tarocrinus multibrachialus var-colletti*, is not a mere variety of this species. It is a valid species and must be known as *Tarocrinus colletti*, if the genus *Tarocrinus* is retained.

We here copy Lyon and Casseday's specific description in full, as follows:

"Body subglobose, where the arms are folded inward as usually the case; from the base to the free arms somewhat discoid, robust, externally covered with minute granules.

"Basal pieces, three, similar in form and sizes forming by their margin apparently the upper joint of the column, slightly thickened opposite the middle of the species.

"Subradial pieces, five, in good specimens presenting five obtusely angular pieces disconnected from each other, resting apparently upon the supra columnar piece.

"Radial pieces first series. Generally four in each ray, the first five (resting between the angular points of the subradials) are irregular in size and form, four are irregularly hexagonal, twice as wide as high, the fifth pentagonal and much smaller than either of the other. The second and third radials are obscurely hexagonal, similar in form, differing slightly in size; the fourth is axillary, obscurely six sided, rising into a long angular point; on each of its oblique upper sides supporting three pieces of the secondary radials, which are similar in form and nearly as large as the first radials. The last of these being axillary, support on their upper oblique margins, each from four to seven brachial pieces; these last are again axillary and bear on one side a branch of from 25 to 30 pieces, on the other branch, which is again divided on the sixth or seventh piece above the first division of the arms, each branch of this last division being composed of about 20 pieces.

"*Interradial fields 1st series.* These fields consist of about fifteen pieces each, the first of which rests upon the upper oblique margin of the first series. Usually hexagonal, small, this supports two of the second row, similar in form and size; these last again support three of the third row of the same form, but a little larger; these again a fourth row differing

slightly in form and size, which are followed by two superior rows of ten pieces each of irregular forms, sometimes there is another at the summit of which completes the field.

“*Interradial fields of the 2d series.* Five, composed of pieces similar in form, from six to seven in number, variously arranged, sometimes one surmounted by two similar pieces, these by two others, then a smaller one or one at the base, with one above the other, these again by two ranges of two, then one, all these forms are occasionally found in the same specimen.

“*Interradial fields of 3d series.* Usually ten, composed of from three to five pieces not regular in form or arrangement, occasionally some of the fields are obscure or absent.

“*Anal pieces six.* The first is septagonal and rests upon the large subradial; upon it are two pieces, nearly similar in size; in the angle formed by their junction is one irregular shaped piece supporting two quite small quadrangular ones.

“The arms are twenty in number, of irregular length, each branch divided into three fingers, making sixty in all. They are free from the third or fourth piece of the third division.

“The arrangement of the several series of interrarial fields between the branches of the arms produces a very large cup in proportion to which the rays are quite short. The general form of our species is somewhat like that of *Ichthyocrinus lavis* (Courad) Hall's figure, New York Geol. Rep. pl. 48 fig. 2. In the arrangement of the rays and the interrarial fields in three series it approaches *Forbesocrinus wortheni* Hall (Iowa pl. 17, fig. 5) from which it differs widely in the number of anal pieces.

“Our specimens are nearly perfect, none of them exhibit the patelloid pieces of *F. Wortheni* Hall. In several species of this genus which have come under our observation there are no patelloid pieces, in a few of our specimens (the prolongation of the superior pieces near the center of their breadth overlapping the inferior) some of the prolongations are fractured; specimens of this character have probably led to the remark of Mr. Hall before cited. It is highly probable that this prolongation in the living animal was less calcareous than the remainder of the piece and owing to this circumstance was differently mineralized from the mass of the piece. This very difference, in the composition of the pieces, supposing that the prolongation was cartilaginous and the rest of the piece bony, would give flexibility to the body of the calyx and

would have been especially useful to our similarly arranged species, whose rays are soldered together by the intercalation of three stories of intermedial and interbrachial fields.

"Our figures are drawn the size of nature from the largest perfect specimens that have come under our notice; fragments have been found of larger individuals.

*"Geological position and locality.* Rare in the beds of the subcarboniferous limestone near to the top of the Knob sandstone, Clear Creek, Hardin county, Kentucky. Also in the same beds in Washington and Montgomery counties, Indiana. Vertical range unknown; it is probable that it is quite limited."

We are inclined to believe that the species was collected in Hardin county, Kentucky. We have not found it in Indiana.

FORBESOCRINUS JERSEYENSIS, n. sp.

*Plate IV, Fig. 2, azygous side of a compressed specimen; Fig. 3, opposite side of same, but the overlapping middle part of the plates has been more or less eroded.*

Species large; plates moderately convex; middle part of the plates overlap the inferior plates, but where eroded the sutures appear to be nearly transverse. Calyx constitutes full two-thirds of the body and is about as wide as high. Interradial areas slightly depressed. Arms slowly contract; they are long and slender above the tertiary series and are infolded at the ends. Column tapers rapidly below the calyx, where it is composed of very thin plates.

Basals within the calyx. Subradials small. Primary radials four in each series, between two and three times as wide as long, the last ones are axillary and support upon each upper sloping side the secondary radials. There are three secondary radials in each series. They are somewhat shorter and narrower than the primary radials. The last ones are axillary and support, upon the upper sloping sides, the tertiary radials. The tertiary radials vary, in number, in the different rays from five to eight. In the proximal series, on the left of the azygous area, there are eight plates, and in the next series five. In the proximal series on the right of the azygous area there are seven plates, and in the next series five. In each ray there are four to six tertiary plates in the proximal series and seven or eight in the distal series. The last tertiary radials are axillary and the proximal rays do not divide, but each distal quaternary series bears an axillary plate and supports the fifth series on each of its superior sides. The number of

quaternary plates in the different distal series varies from nine to twelve. There are, therefore, twelve arms to each ray or sixty arms in this species.

The regular interradial areas are of unequal size, some have only two longitudinal series of plates and others have three. The plates vary in number, in the different areas, from eleven to eighteen. An area having only eleven plates is shown in figure 3 and one having eighteen plates is shown in figure 2. The intersecondary areas are elongated and have from six to nine plates. The intertertiary areas are elongated and have either three or four plates, one following the other. In the azygous area two large plates truncate a subradial, and they are followed by two large plates, and above these, there are three or four plates in a range until the area begins to contract. The superior part of this area is injured in our specimen so that the exact number of plates it contains cannot be determined.

This species resembles *F. multibrachiatus*, in the structure of the arms, as far as the tertiary radials, but above that, there is considerable difference. The interradial areas differ in form and in the number of plates and the azygous areas are widely different. It, however, bears a closer relationship with that species than with any other. The difference in the interradial and azygous areas also makes the two species differ in the form of the calyx.

Found by the late Prof. Wm. McAdams, in the Warsaw Group, in Jersey county, Illinois, and now in the collection of Wm. F. E. Gurley.

#### TAXOCRINUS UNGULA, *n. sp.*

*Plate V, Fig. 1, azygous view; Fig. 2, opposite side of the same specimen.*

Species large and the arms have a fanciful resemblance to numerous claws. The radial series stand out from the interradial areas, and are regularly rounded. The interradial areas are much depressed, and do not extend half the length of the body, including the arms. There are one hundred arms in-folded at the summit. The middle part of each plate overlaps the inferior plate externally, in a sinuous line, as in other species. Surface coarsely granular. Column very large, and tapers rapidly below the calyx, where it is composed of very thin plates.



Basals within the calyx. Subradials medium, or rather more than medium size. Primary radials, four in each series, a little more than twice as wide as long, gradually taper upward and become shorter. They are rounded externally. The last ones are axillary, and support upon the upper sloping sides the secondary radials. There are three secondary radials in each series, except in one of the lateral rays, where there are only two, as shown by figure 2. The last ones are axillary, and support upon the upper sloping sides the tertiary radials. The tertiary radials vary from three to six in the different series. In each of the rays adjoining the azygous area there are three tertiary radials in one and four in the other proximal series, and five in each of the distal series. One of the lateral rays is constructed in the same way, except there are four plates in each of the proximal series. The other lateral ray has six plates in each of the distal series. In the ray opposite the azygous area there are six plates in one of the distal series, otherwise it is like the rays adjoining the azygous area. The last tertiary radials in each series are axillary, and support the fourth series. The distal rays again divide, and each branch of the latter again divides, so that there are twenty arms to each ray. There are, therefore, one hundred arms that curve over upon or infold upon the summit of this species.

The interradial areas are depressed, and differ greatly in size. The plates graduate into those of the vault without any distinct line of separation. The first plate rests between the superior sloping sides of the first primary radials; it is followed by a single plate in one of the areas, by two plates in two of the areas and by three plates in the other area. Above the second range there are two plates, in the third range, in one area, three, in two areas, and four, in the other area. Above the third range the plates are more numerous, and while they unite with the secondary radials, the central ones are much depressed and graduate into those of the vault. The intersecondary areas differ in like manner in size and number of plates. In one area there is only one plate, in the second range, in another there are two, and in another there are four. They so curve in upon the vault that they cannot be distinguished in our specimen beyond the second range. There is one plate in each intertertiary radial area, but it is small and directed toward the vault.

The first azygous plate broadly truncates a subradial, the sides are nearly parallel, and it supports two plates in the second range, one of which only slightly truncates an angle on the left, while the other rests upon the longer, superior, inclined side and supports a series of rather large convex plates. On the right of this series there are some small plates that unite with the primary radials, above the first plate, and on the left there are larger plates connecting the plates with the primary radials. The area curves into the vault so rapidly that none of the plates are shown in our specimen beyond the fourth range.

This species will be readily distinguished from all others, by its general form, and one hundred arms. If *Taxocrinus* is distinguished from *Forbesocrinus*, by supporting, in the azygous area, a central or subcentral series of plates, this is a *Taxocrinus*, but if that is not the generic difference, it might as well be called a *Forbesocrinus*.

Found in the Keokuk Group, at Crawfordsville, Indiana, and now in the collection of Wm. F. E. Gurley.

TAXOCRINUS SPLENDENS, n. sp.

*Plate V, Fig. 3, azygous area on the right; Fig. 4, opposite side of the same specimen, which is compressed.*

Species medium size. The radial series stand out from the interradial areas and are broadly rounded. Interradial areas depressed. There are sixty arms infolded at the summit. The middle part of each plate overlaps the inferior plate externally, in a sinuous line, which is more conspicuous than usual in this genus. Surface pustular. Column tapers very slightly from the calyx where it is composed of very thin plates.

Basals within the calyx. Subradials medium size. Primary radials, four in each series, and they gradually widen from the subradials to the secondary radials, which is the reverse of what we usually find in this genus. They do not increase, correspondingly, in length. The last ones are axillary and support upon the upper sloping sides the secondary radials. There are three secondary radials in each of five series and four in each of the other five, as follows: In the ray on the left of the azygous area three in each series; in the ray on the right and in the ray opposite the azygous area four in each; in one lateral ray three in each, and in the other lateral rays three in one and four in the other. The last ones are axillary

and support upon the upper sloping sides the tertiary radials. The tertiary radials vary from four to ten in the different series, and the arms are not of equal size. The last tertiary radials, in each series, are axillary and support the quaternary radials. The distal rays again divide, which gives to each ray twelve arms. There are, therefore, sixty arms that infold upon the summit of this species.

The interrarial areas are depressed, narrow, elongated, and differ in size and number of plates. The plates graduate into those of the vault without any distinct line of separation. The first plate rests between the superior sloping sides of the first primary radials, and is more or less elongated. It is followed by two plates in the second range, but these are more elongated in some areas than in others, and they differ in size. There are three plates in the third range and above these the plates curve over toward the vault, in the central part of the areas, while uniting at the sides with the secondary radials. A small intersecondary plate may be seen in some of the areas directed inward while it evidently unites with the plates of the vault. The azygous area is narrow, the first plate truncates a subradial and supports a series of rounded plates, on each side of which, smaller plates connect it with the primary radial series.

This species is distinguished by its column, expanding primary radial series, number of secondary and tertiary radials, and by the narrow and elongated interrarial areas. The pustules on the surface are very large though not shown in the illustrations. There is no described species for which it can be mistaken by anyone competent to make a comparison.

Found in the Keokuk Group, at Crawfordsville, Indiana, and now in the collection of Wm. F. E. Gurley.

#### FAMILY PLATYCRINIDÆ.

##### PLATYCRINUS ILLINOISENSIS, n. sp.

*Plate V. Fig. 5, basal view of calyx; Fig. 6, side view of same; Fig. 7, summit view of the calyx of a larger specimen.*

Species about medium size, though there is considerable difference in size among the specimens collected. Calyx bowl-shaped, subpentagonal, broadly truncated below, sutures deeply beveled, radials longitudinally convex. Surface smooth. Plates thick. Column and arms unknown.

Basals form a pentagonal disc, with a height very little exceeding the thickness of the plates, and being slightly concave on the lower side where the column attaches. The first radials stand nearly upright, and are a little longer than wide. They are broadly convex, the greatest convexity being at the margins of the articulating facets. The articulating facets are semicircular, occupy about half the diameter of the plates, are gently concave and directed upward at an angle of about forty-five degrees. The notch for the ambulacral canal is only faintly indicated on each plate.

The azygous interradial, as shown by the angle for its reception, is much larger than either of the other interradials. The vault is probably high, as indicated by the round cavity and indistinct ambulacral notches, though it is not preserved in our specimens.

We do not know of any species with which this one might be confounded, and, therefore, think it is unnecessary to draw comparisons.

Found by C. S. Hodgson, in the Burlington Group, in Adams county, Illinois, and now in the collection of S. A. Miller.

PLATYCRINUS HODGSONI, n. sp.

*Plate V, Fig. 8, basal view; Fig. 9, side view, showing the azygous interradial on the left.*

Species large and wonderfully ornamented. Calyx bowl-shaped, pentagonal, very broadly truncated below, sutures beveled, plates flattened. Surface ornamented with numerous pustules along the beveled sutures and irregular rounded nodes over the interior part of the plates. Plates not very thick. Column round. Arms unknown.

Basals form a large, almost flat, pentagonal disc. It is slightly concave where the column attaches. Column round and radiately lined near the margin. The basal disc and radials are ornamented in the same manner. The first radials are a little longer than wide, and stand nearly upright. They are flattened below the articulating facets. The articulating facets are semicircular, or occupy a little more than the space of half a circle, and a little more than half the diameter of the plates. They are deeply concave and radiately lined for the firm attachment of the second plates. The facets are directed upward at an angle of about forty-five degrees. The notch for the ambulacral canal is only faintly indicated on each plate.

The azygous interradial is a little larger than either of the other interradials, stands nearly upright, but the superior end curves in upon the vault. The surface bears a short spine, and is covered with pustules and nodes in the same manner as the other plates of the calyx.

This species is distinguished by its form, surface ornamentation and radiately lined articulating facets.

Found by C. S. Hodgson, in whose honor we have proposed the specific name, in the Burlington group, in Adams county, Illinois, and now in the collection of S. A. Miller.

REMARKS.—We are led, at this time, after an examination of all of the definitions of the various species of *Platycrinus* described from the palaeozoic rocks of North America, and after having examined fossils belonging to nearly all the species, to make the following observations, notwithstanding it would seem to be more appropriate under a discussion of the genus itself. Some species have not been illustrated and have been so poorly defined that they cannot be determined, without comparison with an authentic specimen, just as they could be determined, if there had been no definition, at all, and, therefore, they are not entitled to recognition. There has been no synonymy, where species have been properly described, and, it is quite possible, there has been none in any case. We recognize one hundred and nineteen species of *Platycrinus* from America.

The two earliest forms are *P. pramaturus* and *P. Siluricus*, from the Niagara Group. They are widely different from each other, and have no resemblance, beyond the generic formula, to any species that followed them. We have no conception of the forms from which they were derived, and are equally in the dark, as to their descendants. If they fall into the life history of *Platycrinus* and all species resulted from evolution, what a world of forms lived in the Silurian and Devonian ages that are yet wholly unknown.

From the Middle Devonian three species have been described, *P. choraceus*, *P. eriensis*, and *P. leai*. The first two are quite peculiar and the last might seem to be a fitting ancestor to the round, cup, turbinate, or bowl-shaped forms occurring, in the Subcarboniferous of later times.

The next described species are found in the lower group of the Subcarboniferous and principally from the Chouteau limestone. Here we find seventeen species, some of them so widely different from all that preceded them and from all that are known in later rocks, that



no resemblance can be traced to any of them, beyond the generic formula. They are as different from a typical *Platycrinus* as the most extreme form of *Eretmocrinus* is from the type of *Batoecrinus*. But, in the Chouteau, we find, in *P. colletti* and *P. chouteauensis*, the commencement of the discoid forms that became so abundant, in the Burlington Group, and, in *P. peltisensis*, the commencement of the pentagonal, bowlshaped forms that abounded in the Burlington Group and survived until the Kaskaskia age. The rounded, turbinate and cup-shaped forms, however, prevailed.

More than twenty distinct, discoid species, of which *P. carus*, *P. gorbyi*, *P. occidentalis*, *P. sulcatus*, *P. discoideus*, *P. excavatus*, *P. striaebrachiatus*, *P. sulciferus*, and *P. formosus* are extreme representatives, have been described from the Burlington Group, but none from rocks of later age, if we except *P. pumilus*, from the Warsaw Group, that has a calyx somewhat discoid in outline. Sixteen species having a pentagonal, bowlshaped outline, of which *P. sampsoni*, *P. missouriensis*, *P. wortheni* and *P. hodysoni* are extreme forms, have been described, from the Burlington Group, and only three from the Keokuk, one from the Warsaw and one from the Kaskaskia. The *Platycrinus* seem to have been in their zenith of development, in the Burlington Group, and to have become extinct, before the close of the subcarboniferous period.

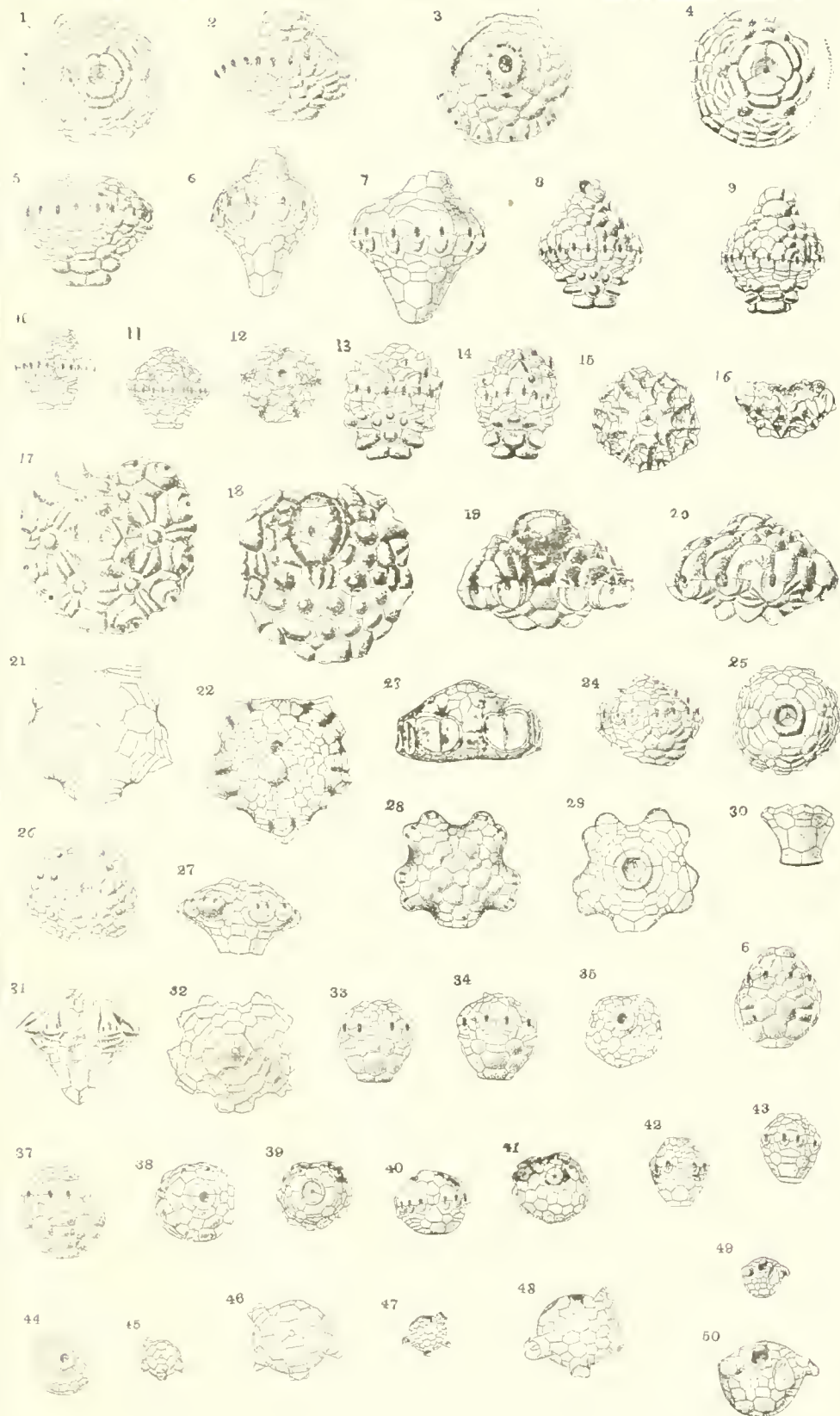
We may divide *Platycrinus* into discoid, bowlshaped, pentagonal, turbinate, hemispherical and urnshaped forms, for convenience of identification and description. But to propose generic or subgeneric names for such subdivisions would be on a par with those proposed by some authors for *Poteriocrinus*, and possess no merit, whatever, in a scientific sense; but, on the contrary, would constitute another stake, driven in the path of progress, for every student and naturalist to stumble over, until some one happened along with the strength and courage to pull it up and throw it away. The variety of forms displayed, in *Platycrinus*, is an evidence of evolution; but until we have become acquainted with many forms that are now unknown and have more correct and settled opinions as to the effect of the environments in shaping the structure of the tests, we can know but little of the life history of the animals.





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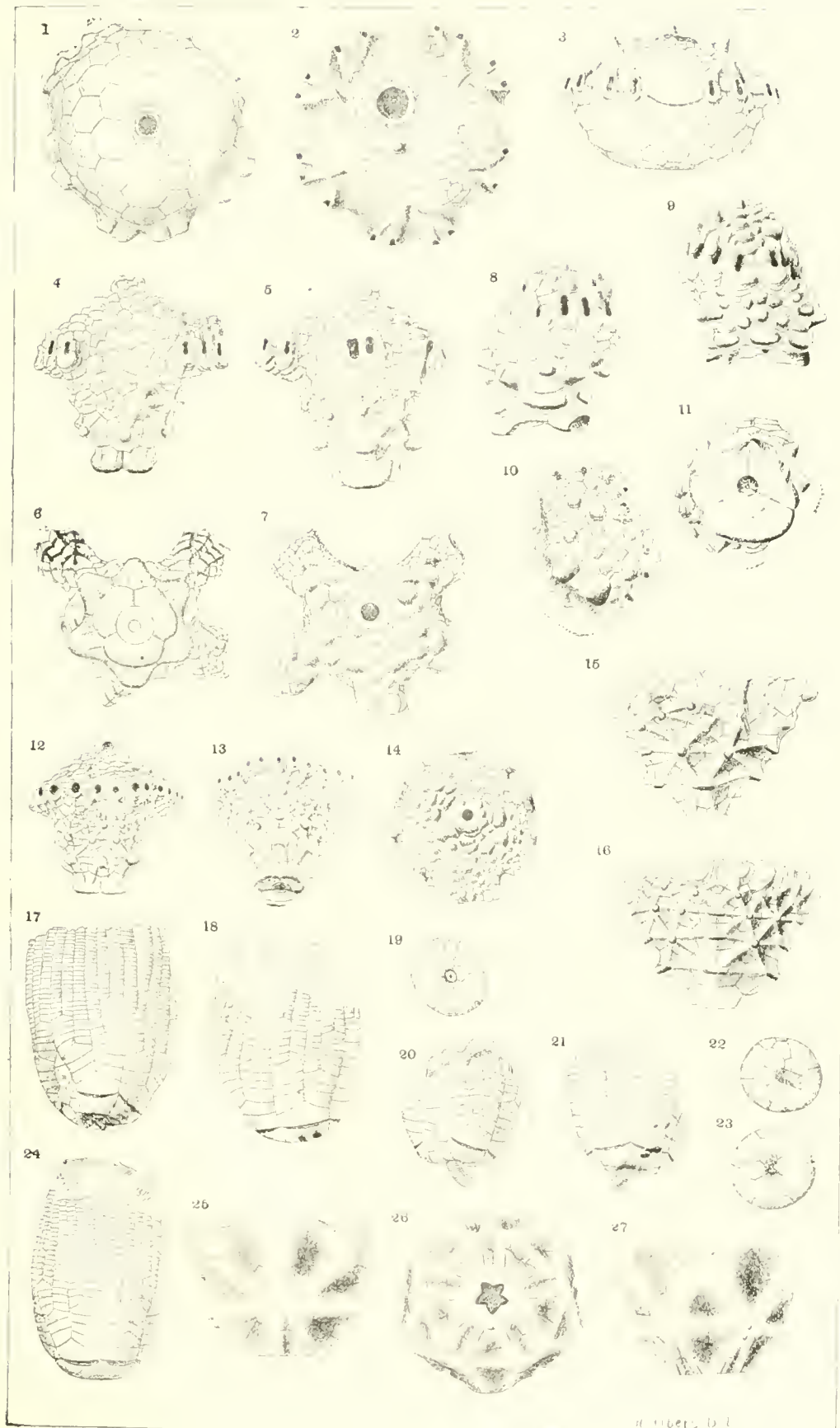




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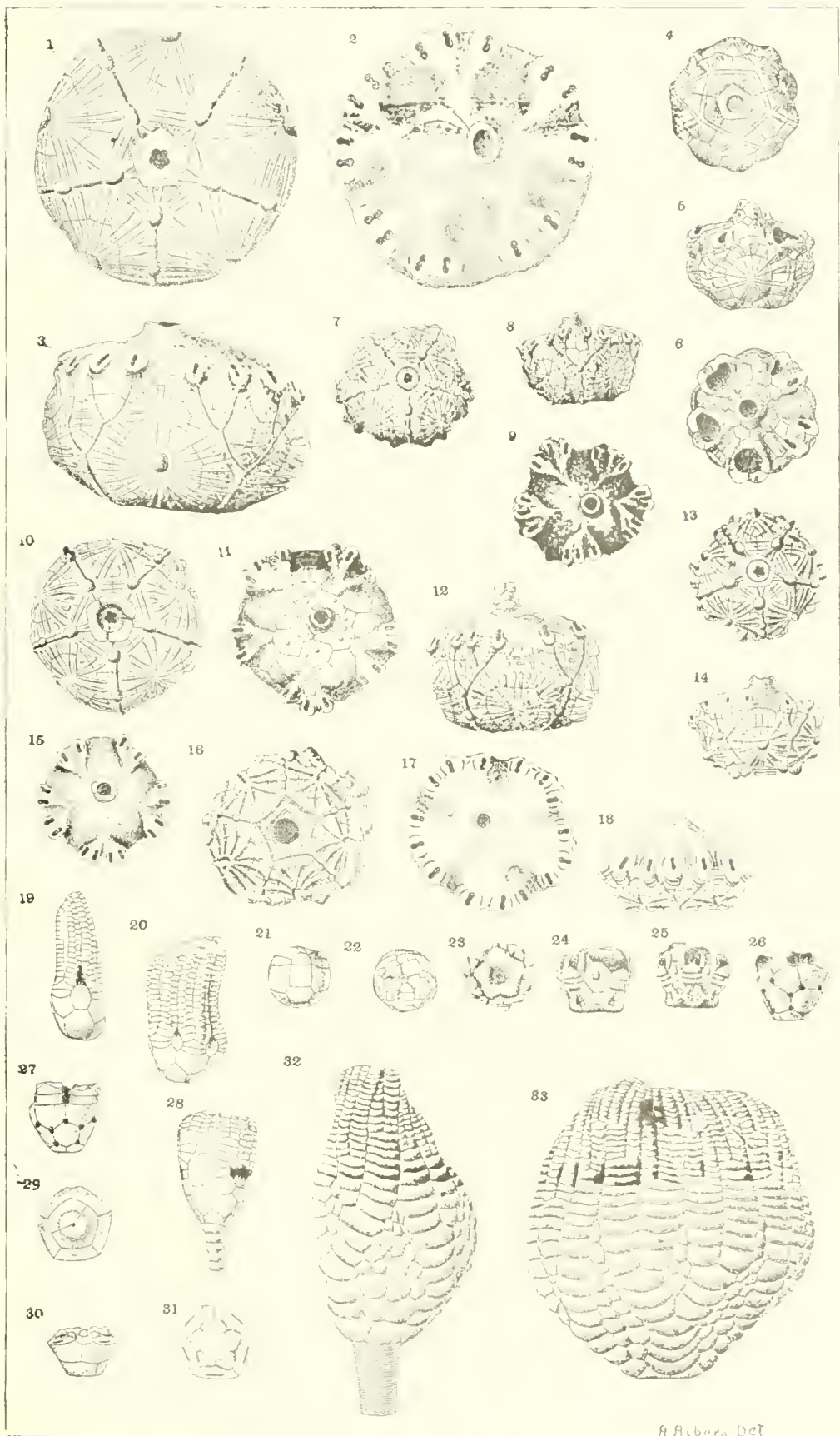






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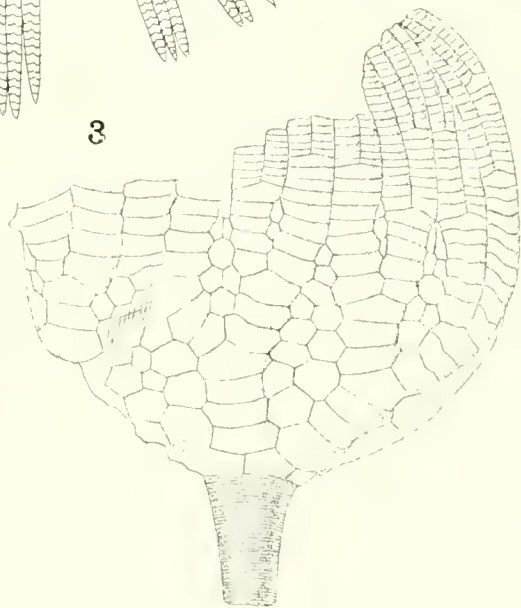
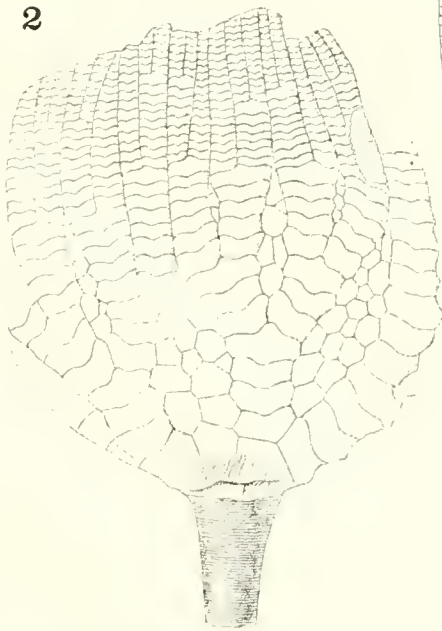
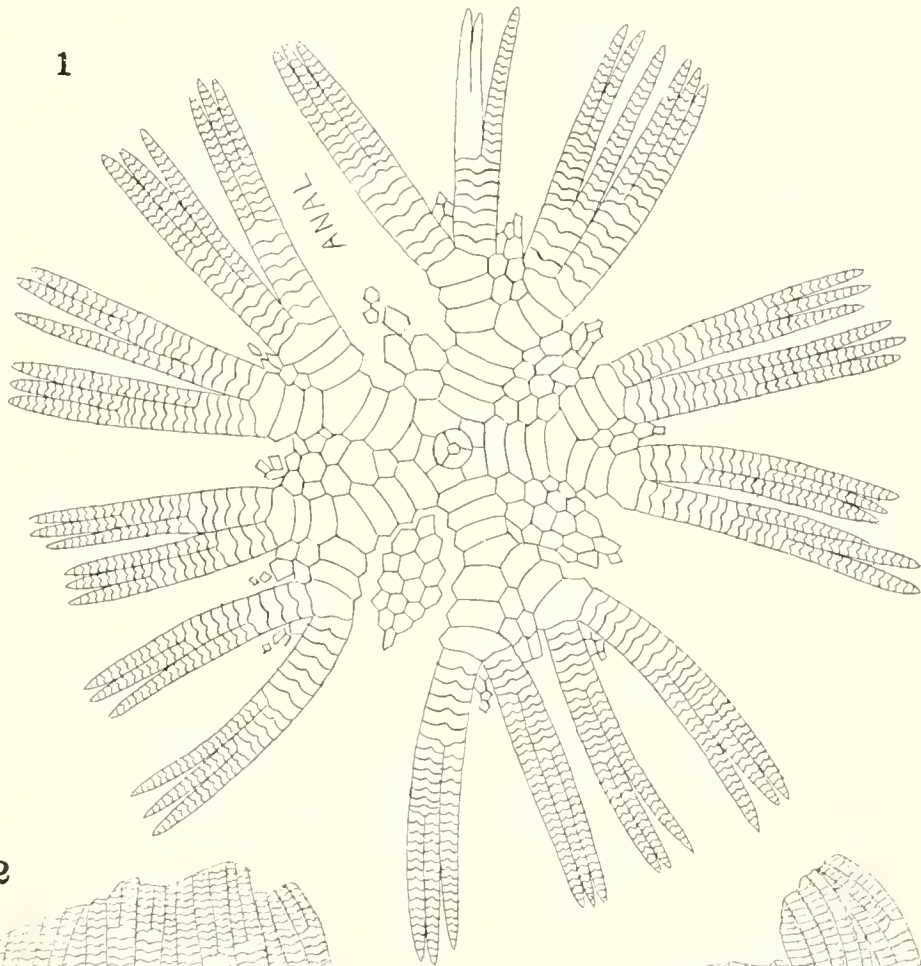






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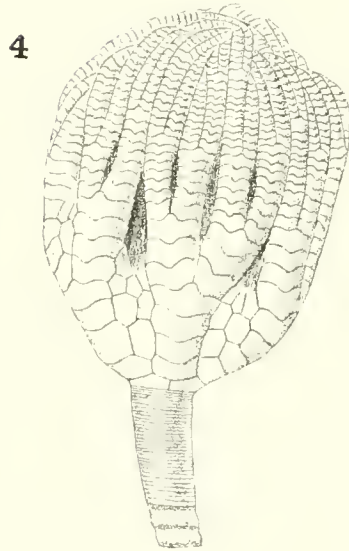
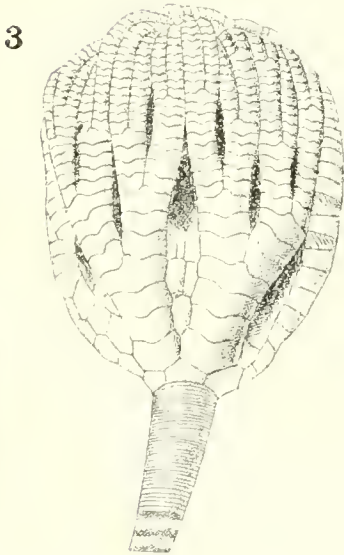
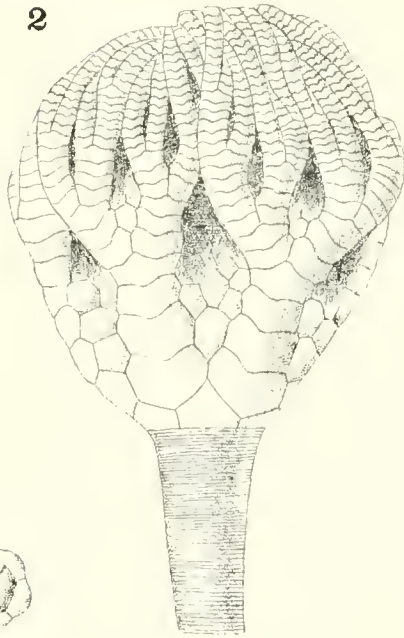
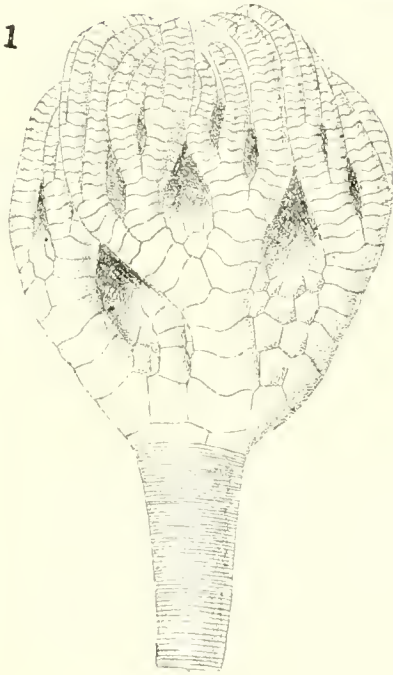




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